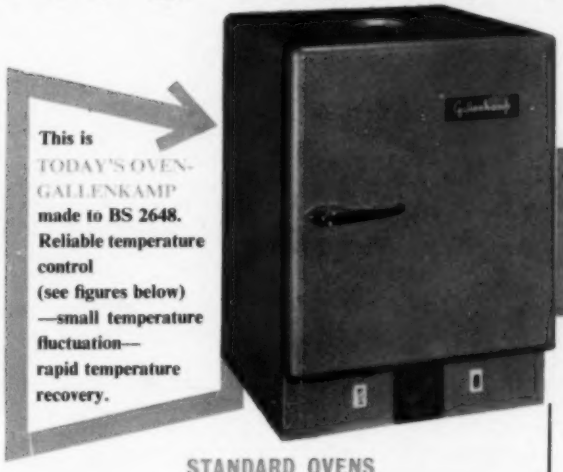
LABORATORY PRACTICE

RESEARCH · CONTROL · TEACHING

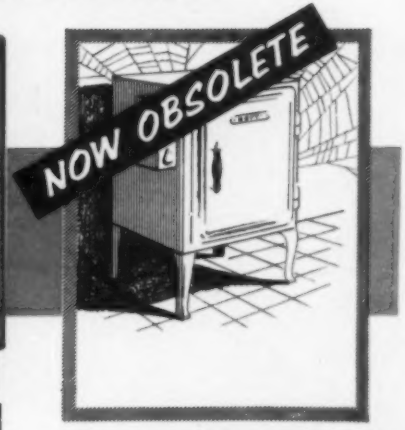
VOL. 10 No. 3 Published Monthly MARCH 1961

hot news

YESTERDAY'S LABORATORY OVENS ARE NOW STONE COLD!



This is TODAY'S OVEN-GALLENKAMP **made to BS 2648. Reliable temperature control (see figures below) —small temperature fluctuation— rapid temperature recovery.**



STANDARD OVENS

SIZE NO.	1	2	3
	°C	°C	°C
Temp. fluctuation at 100°C ...	0.25	0.25	0.25
Spatial temperature variation at 100°C	±2.5	±2.5	±3
Temp. fluctuation at 200°C ...	0.3	0.3	0.3
Spatial temperature variation at 200°C	±6	±6	±7

Ask for Publication 588C— for details of Standard and Mechanical Convection Ovens

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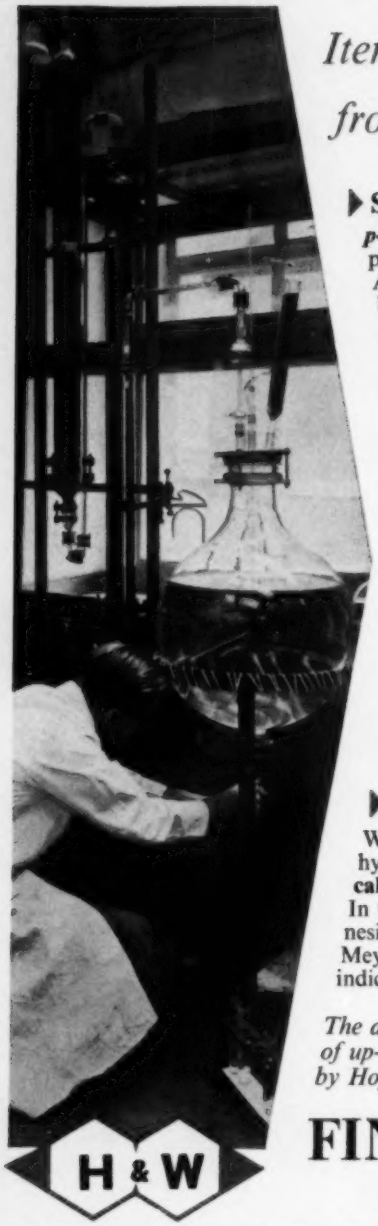
Incidental Information

No. 14



Items of interest

from our laboratory notebooks

Simplified milk phosphatase test

***p*-Nitrophenylphosphoric acid, disodium salt** (*di*-sodium *p*-nitrophenyl phosphate) is used as a substrate in the **milk phosphatase** test of Aschaffenburg and Mullen now gaining in popularity and recognition because of its simplicity and speed. (See *J. Dairy Res.*, **16,** 58 (1949), and *Dairy Ind.*, **18,** 316 (1953)).

We make the reagent and can supply from stock. A suitable Lovibond Comparator for this test is obtainable from Baird & Tatlock (London) Ltd.

Karl Fischer catalyst

This well known method for the determination of **water** is widened in scope and increased in precision by the use of **Karl Fischer Catalyst** (*N*-ethylpiperidine)—available with instructions from Hopkin & Williams Ltd Please write for instruction leaflet.

Uranium by spectrophotometry

Our **1-(2-pyridylazo)-2-naphthol** (**PAN** for short), already known as a metal indicator for complexometric titrations, (H. Flaschka and H. Abdine, *Mikrochim. Acta*, 770 (1956); *Anal. Abs.*, **4,** 794 (1957)) is now described as a spectrophotometric reagent of high specificity for **uranium** (H. Shibata, *Anal. Chim. Acta*, **22,** 479 (1960)).

Sensitive reagent for Calcium

We also make **di-(*o*-hydroxyphenylimino) ethane** (glyoxal-bis-(2-hydroxy anil)), a specific colour reagent for microgram quantities of **calcium** in solution.

In the solid state calcium oxide can be detected in mixtures of magnesium, strontium and barium oxides. (D. Goldstein and C. Stark-Meyers, *Anal. Chim. Acta*, **19,** 437 (1958)). Its use as a complexometric indicator is described by Goldstein in *Anal. Chim. Acta*, **21,** 339 (1959).

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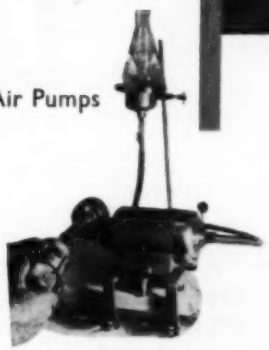

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OPERATION

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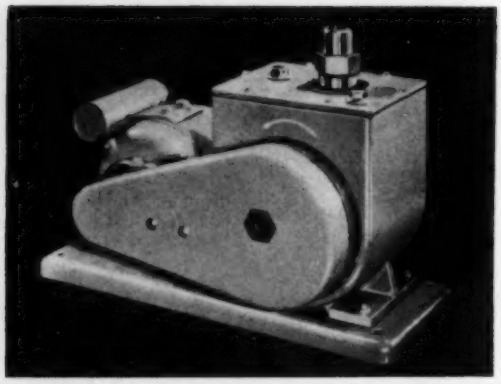

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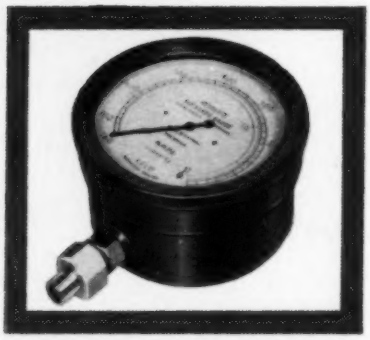

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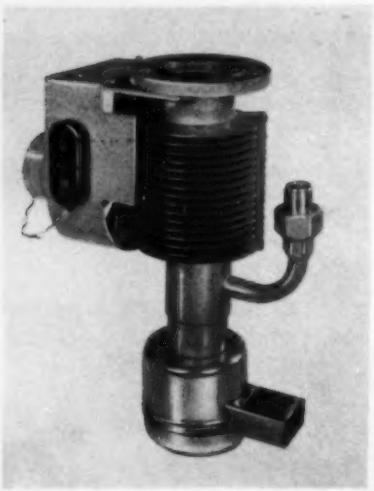

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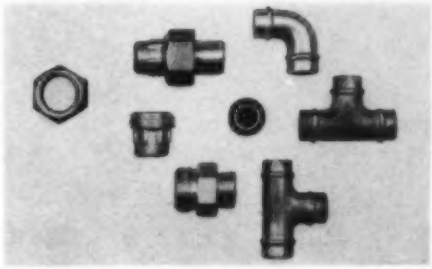

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Cambridge
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Tel: Cambridge 54370

Cardiff
Mervyn House, Frederick Street
Tel: Cardiff 28511/4

Edinburgh
61a Queen Street, 2
Tel: Caledonian 1158/9

Glasgow
74 Waterloo Street, C.2
Tel: Glasgow City 2939

Hull
Seaton Buildings, Jameson St.
Tel: Hull 26832

Ipswich
28 Crown Street
Tel: Ipswich 53941

Leeds
St. Paul's House, St. Paul's St., 1
Tel: Leeds 20718 and 20444/5

Leicester
81 Charles Street
Tel: Leicester 27909

Liverpool
18 Hepworth Chambers,
Church Street, 1
Tel: Royal 4391

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33 Grosvenor Place, S.W.1.
Tel: Belgravia 1234

Manchester
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Tel: Blackfriars 2691
and Ship Canal House, King St., 2
Tel: Deansgate 5031

Middlesbrough
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Nottingham
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Tel: Preston 4253

Sheffield
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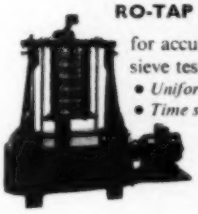

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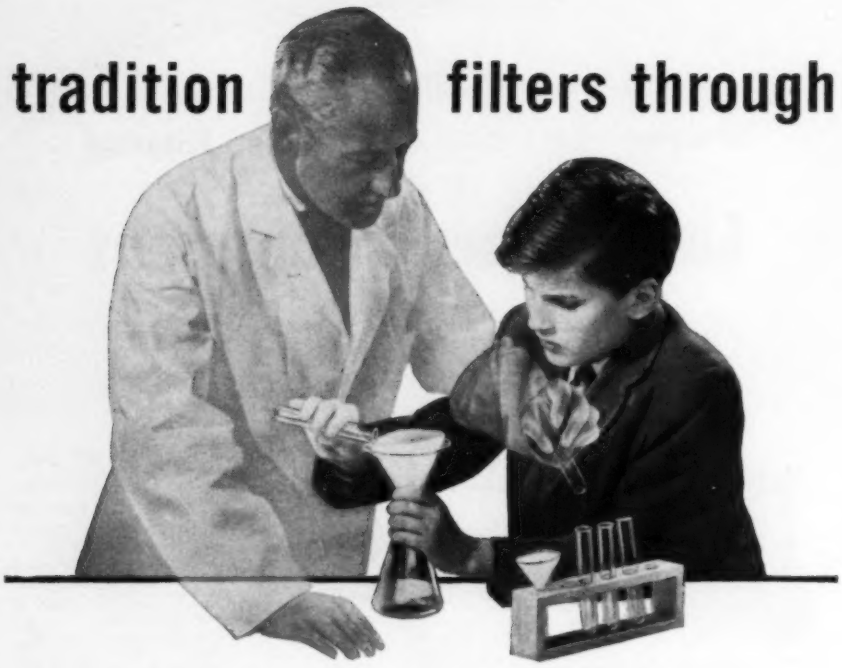

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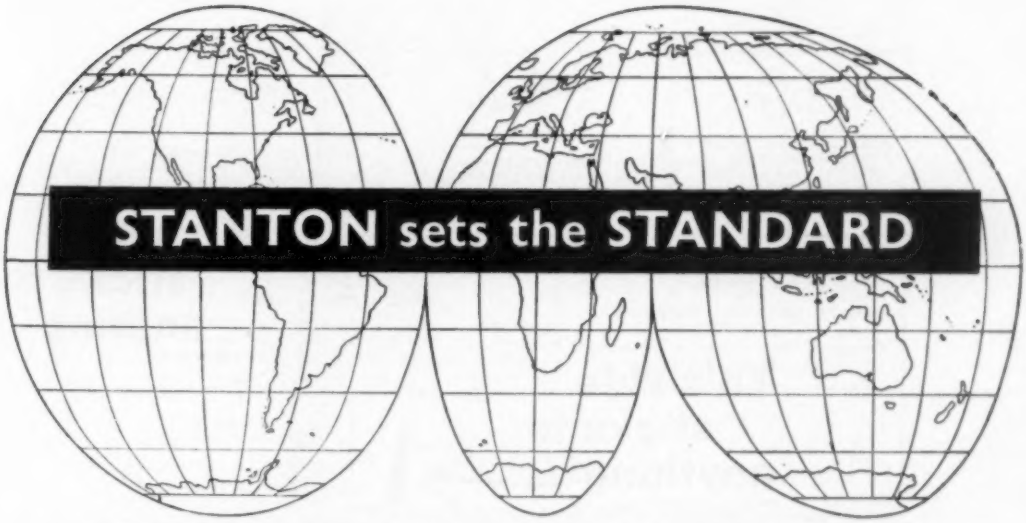

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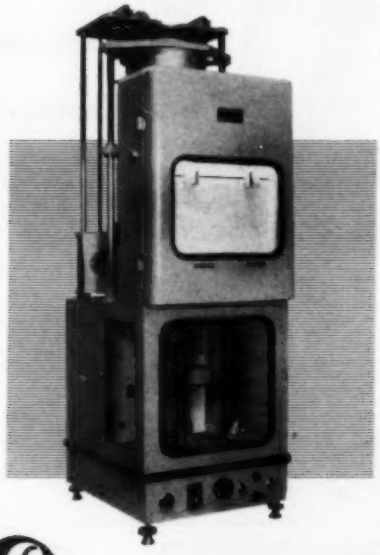

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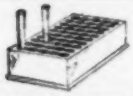

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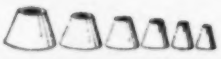

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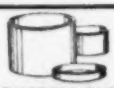

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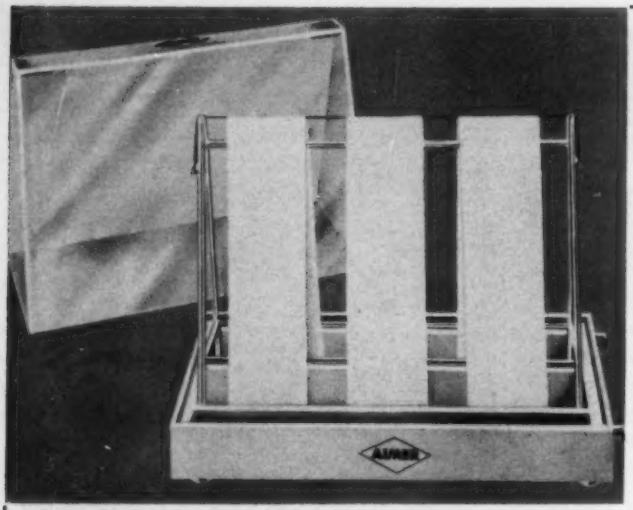

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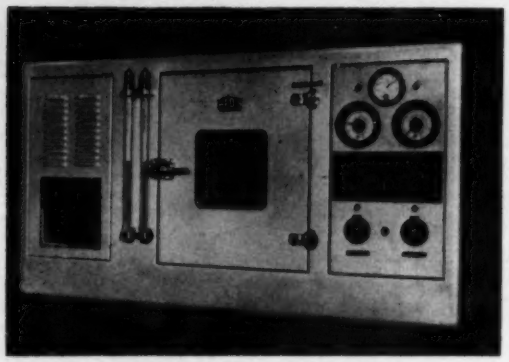

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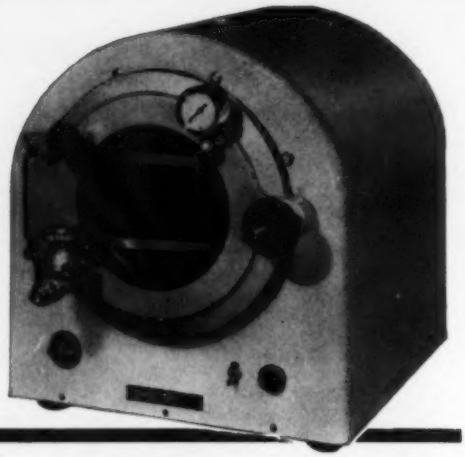

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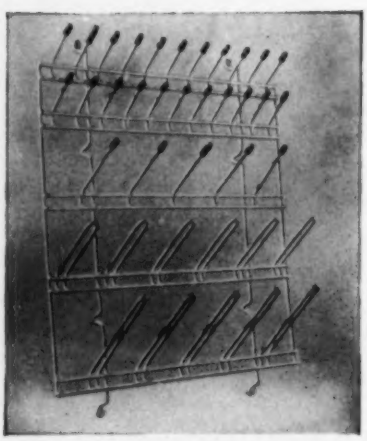

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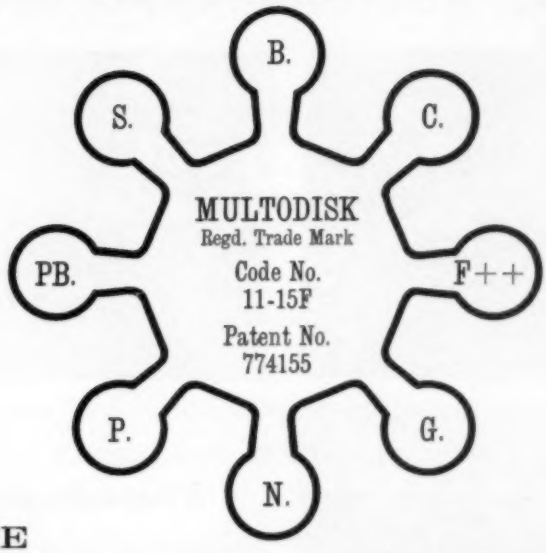

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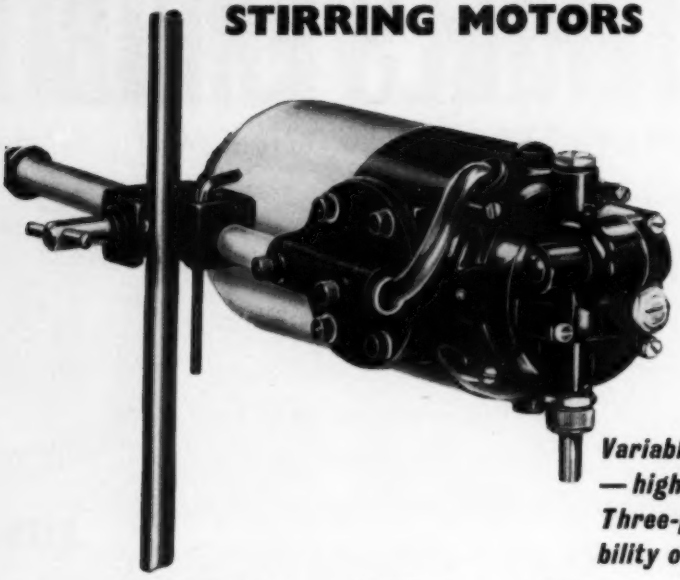

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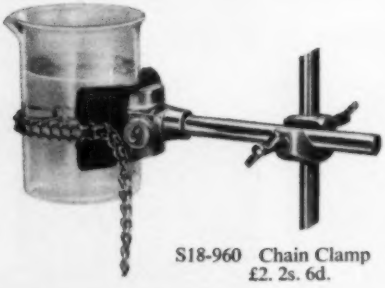

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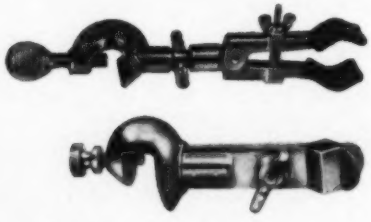

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EDITORIAL

Reprints ONE of the inevitable consequences of the publication of a scientific paper is the question of reprints. Are they to be ordered, and if so how many? One of the mysteries in this field is why the number of requests for a reprint is so unpredictable. The young scientist proudly watches the birth of his first paper and orders 100 reprints, or more probably 200 if someone else is paying for them. He sits back and waits for the wave of requests for 'your most valuable paper', and after a few months has received only three such requests for this epoch-making paper, which contains the germ of an entirely new approach to a scientific problem. One is from a retired professor in an outpost of the empire who claims that he thought of the idea 40 years ago, the second from an earnest young lady in an obscure American university who appears to be looking for a subject for a Ph.D. thesis, and the third is a printed and unsigned card which has obviously come from a collector of reprints. Some time later the author writes a very ordinary article which is purely a review of published work and devoid of any original observations or ideas, and to his surprise his small store of reprints (25 supplied gratis by the journal) is exhausted in a week.

He is annoyed by the lack of interest in his first paper, feels doubtfully flattered by the considerable interest in his second, and altogether feels uncertain about what policy he should adopt in the future. As the years pass by and he becomes gradually case-hardened to this (and all other) problems in life, he settles down to a 'steady state'. In other words he orders 50 or 100 or whatever number he thinks of for each paper, and sends copies to the first 50 or 100 enquirers. Subsequent requests are ignored. However, this rigid attitude is not altogether satisfactory. Most of the early requests may come from members of the Guild of Professional Reprint Collectors (not to be found in any book of reference) and after the supply is exhausted requests may come from well known and distinguished workers in the field. The reprint problem persists and has never been solved, and is far more serious for the individual who has to pay for his own reprints.

What policy can be adopted? Should only letters of request be answered and printed cards ignored? Should reprints be sent only to requests from foreign countries, or to known workers in the field, or personal friends, or persons in isolated laboratories? The last scheme is at least logical. It may be argued that a paper can only be assimilated by careful reading and taking notes, and this can be done as easily in a library as from a reprint in the laboratory.

There can hardly be any obligation on an author to supply gratis a copy of his paper. It is not usually done by authors on other than scientific subjects. Sending a reprint is really a favour, and like other favours, should be reserved for personal friends and those clearly deserving such a favour. However, both authors and the owners of journals appear to like their publications to be better known, and such requests are not altogether devoid of flattery.

When an author is employed by a large organization which supplies not only finance for purchase of reprints but clerical staff to deal with requests, there is hardly a problem. When a man has to buy his reprints and pay for the postage on sending out reprints, the matter is very different. Journals vary in their rules on the question of reprints. Some supply 25 or 50 free, others supply only at cost price, and some unblushingly make a profit out of reprints. Bearing in mind that authors of papers in most scientific journals receive no payment for their work, we suggest that 50 free reprints should be a recognized privilege for all authors who receive no payment.

One interesting aspect is whether it is cheaper to write to all authors for a reprint instead of subscribing to the journal. Possibly some account-minded scientist has already looked into this question.

Whatever policy is adopted by a scientific worker there are problems—what is the best and fairest policy for both author and requester of reprints? Some governmental authorities make a small charge for reprints. This should certainly discourage all but those who definitely want a certain paper—it is rather a nuisance to set about sending 9d. to U.S.A. One extreme policy would be to have no reprints at all; the other would be to provide 50 free and an unlimited number at a price below cost. We shall welcome readers' views on this controversial question.

Forthcoming Conferences

2nd Conference of X-ray Analytical Methods

A Conference will be held on X-ray Analytical Methods by Research and Control Instruments Ltd., in conjunction with the Department of Geology at The University, Manchester, from Monday, March 20 to Friday March 24, 1961. This year the Conference will discuss and evaluate the latest techniques and instrumentation of x-ray fluorescensce analysis. An extensive range of modern equipment will be available for demonstrating the principles of these methods over a wide field of applications.

Full information concerning the Conference together with details of the registration fees may be obtained from the Conference Secretary at Research and Control Instruments Ltd., Instrument House, 207 King's Cross Road, London, W.C.1.

The Nutrition Society

The following is the programme of a symposium to be held at the London School of Hygiene and Tropical Medicine, London, W.C.1, at 10.30 a.m. on Saturday, March 18, 1961 on 'The Place of Food Science and Technology in the Campaign against Malnutrition,' under the chairmanship of Dr. W. R. Aykroyd, C.B.E.

Dr. K. K. Halder (India) Dr. O. Kiksal (Turkey) Mr. W. Frankul (Iraq) Mr. S. M. Ali (Pakistan) Mr. R. Orra ca-Tetteh (Ghana)	'Problems and some Solutions.'
Dr. F. Aylward (Borough Polytechnic, London, S.E.1.)	'Some African Problems.'
Dr. F. Wokes (King's Langley, Herts.)	'India's Food Problems.'
Dr. W. F. J. Cuthbertson (Glaxo Laboratories Ltd. Middlesex.)	'The Commercial Development of "Amama," a Protein-rich Supplement, in Nigeria.'
Dr. J. W. Corran (J. & J. Colman Ltd., Norwich.)	'Factors affecting Development of Food Science and Technology and Food Resources in Pakistan.'
Dr. A. T. M. Wilson (Unilever House, London, E.C.4.)	'Nutritional Change: Some Comments from Social Research.'

Further details may be obtained from the Hon. Programmes Secretary of The Nutrition Society, Miss D. F. Hollingsworth, c/o Ministry of Agriculture, Fisheries and Food, Great Westminster House, Horseferry Road, S.W.1.

International Symposium on Microchemical Techniques

This Symposium will be held from August 13 to August 18, 1961, at the Pennsylvania State University, University Park, Pennsylvania, U.S.A.

Organized by the Metropolitan Microchemical Society under the sponsorship of the International Union of Pure and Applied Chemistry, the technical programme will consist of a number of main introductory lectures and a full schedule of invited papers directed toward new methods and techniques or unique applications of microchemical or microanalytical interest. There have already been acceptances from speakers from Argentina, Australia, Austria, Belgium, England, France, Germany, Hungary, India, Ireland, Israel, Japan, Poland and Switzerland as well as the United States of America. English will be the preferred language, but every effort will be made to have adequate translation facilities available.

A series of social activities will be held to facilitate the informal meeting of the participants. In addition a separate ladies programme is planned.

A commercial exhibit of laboratory equipment, chemicals and specialities will be held in conjunction with the meeting. It is also hoped to schedule one session at which participants can demonstrate novel, non-commercialized techniques and apparatus which they have personally developed.

All individuals interested in receiving further details as they are made available, should send complete name and address to:

Mr. Howard J. Francis, Jr.,
Vice Chairman, International Symposium on Microchemical Techniques,
c/o Pennsalt Chemicals Corporation,
Post Office Box 4388,
Philadelphia 18, Pennsylvania, U.S.A.

LABORATORY EQUIPMENT TEST REPORT—No. 41

CHROMATOGRAPHIC DESALTING APPARATUS

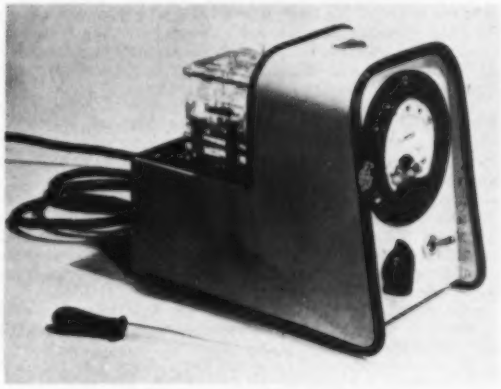
Manufacturers: Baird & Tatlock (London) Ltd., Chadwell Heath, Essex.

Price: £29. 15s. 0d.

Introduction

It is sometimes necessary to reduce the salt concentration of solutions containing amino acids or other substances before a satisfactory separation can be achieved by paper chromatography. The choice of method used for desalting in such circumstances depends largely on the relative needs for speed or for quantitative recoveries. Thus with amino acids although electrolytic desalting can be accomplished quickly it does cause some losses, whereas desalting with short columns of ion-exchange resin is more time-consuming but the amino acids are recovered quantitatively.

This electrolytic desalting apparatus by Baird & Tatlock is based on that described by Blainey and Yardley (*Nature*, 1956, **177**, 83) and represents a worthwhile improvement on the older mercury type of electrolytic desalter.



B.T.L. chromatographic desalting apparatus.

Description

The apparatus consists of a cell unit and of a power supply to transform and rectify the a.c. mains and provide the required low voltage d.c.

The cell unit is neatly constructed from Perspex and consists of three compartments which are clamped together with four bolts. The two outer compartments contain platinum clad electrodes, one marked positive (anode) and the other negative (cathode). The anode is separated from the centre compartment by a sheet of anion exchange membrane and the cathode by a sheet of cation exchange membrane. The centre compartment contains three cells having capacities of 1, 2 and 3 ml., respectively; one or more of the cells may be used simultaneously so that solutions of up to 6 ml. in volume may be desalted in one operation.

The power supply consists of a transformer, with a switch in the mains input, and a half-wave metal rectifier. The current flowing through the cell is indicated on a milliammeter reading from 0-100 ma. and can be adjusted by a potentiometer.

Operation

The assembly of the cell unit and the operation of the apparatus are quite straightforward and are fully described in the instructions with the instrument. Once the membranes have been inserted it is important to keep all the compartments filled with water to prevent drying out.

To use the apparatus the compartment housing the anode is emptied and then filled with 0·2 N sodium hydroxide and that housing the cathode with 0·2 N sulphuric acid. One or more of the centre compartments are emptied and then filled with the solution to be desalted. The current is then switched on and adjusted to be about 50 ma. and the solution is gently agitated by blowing in air from time to time. When the current is passed, the anion exchange membrane permits anions to move out of the centre compartment into the anode compartment while retaining cations, and the cation membrane allows cations to move out into the cathode compartment but holds back anions. Thus there is a net loss of electrolytes from the centre compartment, with the result that after about five minutes the current slowly falls. It was found best to stop desalting within one minute of the current starting to fall in order to minimize losses of amino acids. The rate of fall of current with this apparatus was not as high as that reported by Blainey and Yardley (*loc. cit*) who were passing current from a 6 V. accumulator, probably because the output voltage from the mains' transformer rises somewhat as the current drawn falls, whereas the e.m.f. of an accumulator is essentially independent of the current drawn.

Desalting Solutions of Amino Acids

Desalting solutions of amino acids by electrolytic methods is somewhat of a misnomer as the technique cannot be used to remove all the electrolytes from the solution without unacceptable losses of the amino acids themselves. The method should be considered as providing a quick way of reducing the concentration of electrolytes in the solution and thus yielding a partially desalted solution that can be resolved into its components by paper chromatography.

(*Concluded at foot of page 154.*)

New Officers of the Royal Society

At the Anniversary Meeting of the Royal Society Sir Howard Florey was elected President of the Society in succession to Sir Cyril Hinshelwood.

Sir Howard Florey was born in Adelaide in 1898 and after attending St. Peter's College and Adelaide University (1916-21) proceeded to Magdalen College, Oxford, as a Rhodes Scholar. He later studied at Cambridge and at the London Hospital, and was Rockefeller Travelling Fellow in the United States, 1925-6. Subsequently he held appointments at Cambridge and Sheffield before becoming in 1935 Professor of Pathology at Oxford University.

Sir Howard Florey has made a number of outstanding contributions to experimental pathology and medical science. He is best known for his work in connection with the isolation and detailed study of penicillin and its development as a successful non-toxic anti-bacterial agent for use in medical treatment. For this work he shared the Nobel Prize for Medicine in 1945 with Prof. E. B. Chain and Sir Alexander Fleming. Since 1945, with his collaborators, he has continued to work on the discovery and properties of new antibiotics and latterly has been investigating the underlying disturbances in certain arterial diseases.

He played a part in setting up the Australian National University, being especially connected with the John Curtin School of Medical Research.

He was elected a Fellow of the Royal Society in 1941 and was awarded a Royal Medal in 1951 for his distinguished contributions to pathology by his studies of the functions of mucin and by his work on penicillin and other antibiotics. He was awarded the Copley Medal in 1957 in recognition of his distinguished contributions to experimental pathology and medicine. He delivered the Society's Croonian Lecture in 1954 on 'Mucins and the Protection of the Body'. He has previously served on the Council of the Royal Society, in 1942-3 and 1951-3.

The new Treasurer of the Royal Society is Sir Alexander Fleck, K.B.E., who recently retired as Chairman of Imperial Chemical Industries Ltd., and who was elected a Fellow of the Royal Society in 1955. He was born in 1889 in Glasgow and his early work at Glasgow University on the chemistry of thorium, uranium-X and other radioactive elements provided experimental foundation for ideas on isotopes, the α and β law, and movements of isotopes within the periodic system, which were developed by Soddy. Later scientific studies bore on industrial problems—properties of sodium and mechanization of the electrolytic process, properties of trichlorethylene and of calcium sulphate, etc.—and his scientific knowledge has been applied in the integration of large sections of the British chemical industry. He was on the staff of the Castner-Kellner Company from 1917 to 1926, Chairman of the Billingham Division of I.C.I. Ltd. 1937-45, a Director of I.C.I. 1944-51 and Chairman 1953-60. He was Chairman of the National Coal Board Organization Committee 1953-55. He was President of the British Association for the Advancement of Science 1958.

Sir Patrick Linstead, C.B.E., Rector of the Imperial College of Science and Technology since 1955, was elected Foreign Secretary. He was born in 1902 and educated at the City of London School and Imperial College. For a time he was on the staff at Imperial College and later occupied chairs of chemistry in Sheffield (1938-9) and Harvard (1939-42). He was Deputy Director of Scientific Research in the Ministry of Supply (1942-5) and Director of the Chemical Research Laboratory of the Department of Scientific and Industrial Research before returning in 1949 to Imperial College as Professor of Organic Chemistry. His scientific work has covered a wide field including studies of unsaturated acids, carbo-cyclic fused-ring compounds, hydrogen transfer, the structure of chorophyll, and the stereochemistry of catalytic hydrogenation. His name, however, will always be associated with the study of phthalocyanine, the azaporphins and allied compounds. He was elected a Fellow of the Royal Society in 1940 and served on the Council for 1949 to 1951 and in 1959-60.

Sir Lindor Brown, C.B.E., Waynflete Professor of Physiology at Oxford University, and Sir William Hodge, Lowndean Professor of Geometry and Astronomy in the University of Cambridge, were re-elected Biological Secretary and Physical Secretary respectively.

Other members of Council elected were:

Prof. J. F. Baker, O.B.E., Professor of Mechanical Sciences in the University of Cambridge.

Mr. R. P. Bell, Reader in Physical Chemistry, Oxford University.

Dr. J. C. Burkill, University Lecturer in Mathematics, Cambridge.

Prof. D. G. Catcheside, Professor of Microbiology in the University of Birmingham.

Prof. J. E. Harris, Professor of Zoology in the University of Bristol.

Prof. T. M. Harris, Professor of Botany in the University of Reading.

Prof. A. F. Huxley, Jodrell Professor of Physiology at University College in the University of London.

Sir Christopher Ingold, Professor of Chemistry in the University of London at University College.

Dame Kathleen Lonsdale, D.B.E., Professor of Chemistry at University College, London.

Dr. R. A. Lyttleton, Reader in Theoretical Astronomy in the University of Cambridge.

Dr. R. G. Macfarlane, Reader in Haematology, Oxford University.

Prof. R. A. Morton, Johnston Professor of Biochemistry in the University of Liverpool.

Sir Alfred Pugsley, O.B.E., Professor of Civil Engineering in the University of Bristol.

Dr. C. J. Stubblefield, Assistant Director of the Geological Survey of Great Britain.

Sir Gordon Sutherland, Director of the National Physical Laboratory.

Prof. C. H. Waddington, C.B.E., Professor of Animal Genetics in the University of Edinburgh.

Chromatographic Desalting Apparatus

(*Concluded from page 153*)

A number of trials were carried out with standard solutions of amino acids containing known amounts of inorganic electrolytes. The apparatus functioned satisfactorily, though after some months of use the anode showed signs of corrosion, probably due to a flaw in the plating. It would seem that this could be avoided by constructing the electrodes of pure platinum wire. The membranes clearly have a long life, and in any event are cheap and easily replaced. Tests showed that a desalting time of six minutes was the most satisfactory for removing the largest amount (50-70 per cent) of electrolyte concomitant with reasonably small losses of basic amino acids. These losses were minimized by adjusting the initial pH of the solution to 8·5, but even so some 15-17 per cent of lysine and arginine were lost; losses of other amino acids did not exceed 7 per cent.

Conclusion

There can be no doubt that within the limits of electrolytic desalting this type of apparatus represents a worthwhile advance. The equipment tested was well designed and constructed and was simple to use.

ORIGINAL CONTRIBUTION

A NEW METHOD FOR THE POLAROGRAPHIC DETERMINATION OF CYANIDE

by J. Hetman

Southern Analytical Limited, Camberley, Surrey, England

A method is described for the polarographic determination of cyanide. Although anodic[1] or anodic/cathodic reactions of cyanide at the dropping mercury electrode have previously been reported, the present method depends on a pure reduction wave. A base electrolyte composed of pyridine and potassium nitrate together with a mercuric salt is employed. The method is straightforward and allows the determination of cyanide in concentrations down to 1 p.p.m. with a comparatively simple polarograph.

THIS work follows from a method previously developed for the polarographic determination of mercury fulminate[2] in a base electrolyte of pyridine and potassium nitrate. In the course of this investigation, the effect of cyanide on the reduction wave of fulminate was investigated and it was shown that cyanide also gave a reduction wave. This suggested the possibility of determining cyanides in a base electrolyte of pyridine and potassium nitrate without the presence of mercury fulminate, but under these conditions no reduction wave for cyanide was obtained, which seemed to indicate that a mercuric salt must be an essential part of the base electrolyte.

No work concerning the polarographic reduction of cyanide has been reported in the literature, although the possibility of an anodic/cathodic reaction in the presence of dissolved oxygen has been suggested by Ralea *et al.*[3] In the present work a quantitative reduction process takes place and linearity between the diffusion current and the concentration of cyanide is preserved for a wide range of concentrations.

In the absence of mercuric ions no reduction takes place, but if the concentration of the mercuric ion is about equal to the cyanide concentration, the formation of a reduction wave is observed near zero potential. Increasing the concentration of the mercuric ion has the effect of shifting the half-wave potential to more negative values and with a 20-fold increase in the concentration of the Hg ion the halfwave potential reaches its most negative value. With further increases of Hg, i.e. 100 fold, serious interference takes place. Variation in the half-wave potential with concentration of mercuric chloride and linearity is shown in Fig. 1 and 2.

Apparatus

A Southern Analytical Limited Manual Polarograph A1650 was used for this investigation, with a conventional cell with a mercury pool as anode. A drop rate of 2 sec. was used and points were plotted at intervals of 50 mV.

Reagents

Pyridine 'AnalaR'
1·0 M potassium nitrate
Mercuric chloride 2 g./litre
Gelatine solution 0·2 per cent.

Experimental

A 0·1 N solution of KCN was prepared and diluted to make a concentration of 2·5 mg./ml. (Solution A) and using a microburette, 0·16, 0·24 and 0·32 ml. of this were introduced into three 20 ml. flask, containing:

2 ml. mercuric chloride (2·0 mg./ml.)
2 ml. pyridine
2 ml. gelatine solution

and made up to the mark with 1·0 N KNO_3; hence the concentrations of CN in the three flasks were 20, 30, and 40 p.p.m. A 5 ml. aliquot of each solution was taken and introduced into a cell in turn and deoxygenated with hydrogen for 10 minutes and the polarograms were plotted from 0 to −0·5 V. at intervals of 50 mV. The results are shown in Fig. 1.

p.p.m.	*Wave Height*	$E_{\frac{1}{2}}$ *vs Hg pool*
20	38	−0·36
30	56	−0·32
40	77	−0·22

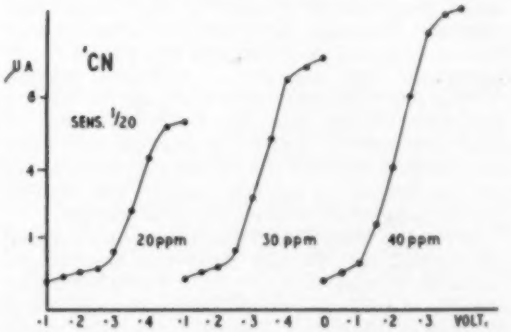


Fig. 1.

ARTICLES

In order to determine whether the above relationship of wave height was preserved at low concentrations, 0·08, 0·16, and 0·24 ml. of a further five-fold dilution of solution A were taken and the operation repeated as described previously, and the polarograms recorded as before.

p.p.m.	*Wave Height*	$E_{\frac{1}{2}}$ *vs Hg pool*
2	11	−0·37
4	19·5	−0·35
6	30	−0·33

Easily measurable waves were obtained suitable for quantitative determinations as shown in Fig. 2.

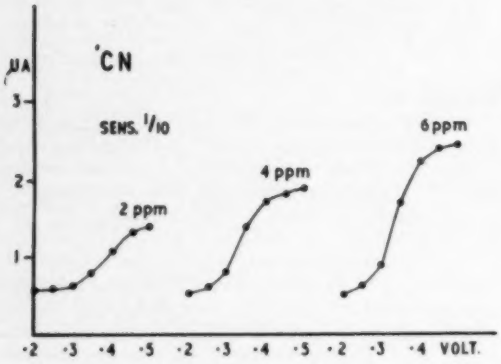


Fig. 2.

Interfering Ions

The effect of the presence of various substances on the reduction wave has also been investigated. If the concentration of KNO_3 is in the range 0·25 M to 2·0 M no interference is observed. If, however, the concentration is reduced below 0·25 M deformation of the wave occurs. The addition of chloride or sulphate ion is without effect although the half-wave potential is shifted to more positive values due to the influence of added anions on the potential of the mercury pool electrode. Ammonia, phosphates and azides (NaN_3) have no effect, nor do the metallic ions Zn, Ni, Co, Cr (chromate). The addition of hydrazine sulphate $N_2H_4H_2SO_4$ also causes no interference, nor does the presence of acetates. Experiments were also carried out with acrilonitrile CH_2CH CN and p-chloro-phenyl acetonitrile $C_6H_4ClCH_2CN$, neither of which caused any interference. Cu seriously interferes and sulphides (Na_2S) bring about the precipitation of mercury.

In order to confirm this work, a further investigation was carried out. To four flasks each containing a synthetic solution of Cr^{+6} 5 p.p.m., Ni 10 p.p.m., Zn 100 p.p.m. and Co 80 p.p.m. in ammoniacal medium (N NH_4OH), CN was added to make concentrations of 15, 20, 25, and 30 p.p.m. The estimation of the CN in these samples was carried out as follows: 5 ml. of sample was transferred to four 10 ml. flasks, together with 1 ml. pyridine, 0·15 ml. saturated mercuric chloride, 0·2 ml. gelatine solution, made up to the mark with N KNO_3 and the polarograms recorded in the usual way on 5 ml. aliquots. The standard addition method was used to determine the cyanide with the following results:

Sample	*CN taken p.p.m.*	*CN recovered p.p.m.*
1	10	9
2	15	12
3	20	18
4	30	27

Applications

The method has the advantage of simplicity and could be adapted for the determination of cyanides in various industrial effluents and in air. It is possible to determine cyanide in a large excess of acrilonitrile which itself can be determined polarographically in 0·3 M, tetraethyl-ammonium bromide $E_{\frac{1}{2}} = -1{\cdot}75$[4]. Cyanide can also be determined in the presence of hydrazine sulphate azides, ammonia and p-chloro-phenyl acetonitrile. When materials contain interfering ions, e.g. Cu, the usual methods of distillation of cyanides can be applied.

ACKNOWLEDGMENT.—*The author wishes to thank Mr. C. Wontner of Southern Analytical Limited for his valuable help in the experimental work and in the operation of the manual polarograph.*

REFERENCES

[1]Hetman, J. (1960). Determination of Traces of Cyanide in Water by Cathode Ray Polarograph. J. Appl. Chem., **10**, 16-18.
[2]Hetman, J. (1959). The Application of the Cathode Ray Polarograph to the Analysis of Explosives. The Determination of Mercury Fulminate. Talanta, 3, 127.
[3]Ralea, R., Mayer, A. and Burlacu, G. H. (1959). Academia. R.P.R. Filiali Iasi. Chimie Anul X, Fasc. 1.
[4]Unpublished work by the author.

Rheological Techniques

The British Society of Rheology and the Non-Destructive Testing Group of the Institute of Physics and Physical Society will hold a joint meeting on this subject at Llandudno on September 21 and 22, 1961. The aim of the meeting will be to discuss rheological techniques in detail. Usually in the presentation of a paper, discussion of experimental results is given at the expense of the description of the techniques. It is intended that on this occasion the opposite will be true.

The proceedings of the meeting will be published in special issues of *Laboratory Practice*.

Contributions to the meeting are invited, and intending speakers should write as soon as possible to:

Dr. M. F. Culpin,
8 The Broadway,
Pontypool,
Monmouthshire.

MAGNETOCHEMISTRY

A. Earnshaw, Ph.D.

Battersea College of Technology, London, S.W.11

PART II—THE CONSTRUCTION OF A GOUY BALANCE

AS WAS mentioned in the previous article, the effect of a non-homogeneous magnetic field on a body is to attract or repel it; and the magnitude of this force of attraction or repulsion is dependent on the magnetic susceptibility of the body. A simple apparatus for measuring this force, and hence the susceptibility was devised by Gouy[2]. Essentially this method is based on the suspension of a cylindrical sample of the substance in question in a non-homogeneous magnetic field and the measurement by a conventional weighing technique of the force exerted on it.

Consider a uniform cylindrical body 1 cm. long, of cross sectional area A, suspended vertically with its base in a field H_1, and its top in a field H_0.

If the field gradient at a particular point is $\frac{\partial H}{\partial l}$, the force exerted on a small element of the body is:

$$f = (\varkappa_1 - \varkappa_2)\, v\, H \frac{\partial H}{\partial l} \qquad (1)$$

where $\varkappa_1$ is the susceptibility per unit volume of the specimen,

$\varkappa_2$ is the susceptibility per unit volume of the displaced medium

and v is the volume of the body.

Integration gives F, the force acting on the whole cylinder.

$$\int f\, \partial l = (\varkappa_1 - \varkappa_2)\, v \int_{H = H_0}^{H = H_1} H\, \partial H$$

$$\therefore Fl = \tfrac{1}{2}(\varkappa_1 - \varkappa_2)\, v\, (H_1^2 - H_0^2) \qquad (2)$$

However $v = Al$, and if it is arranged that the cylinder hangs with its lower end in the region of maximum field, H, and its upper end in an effectively zero field, (2) reduces to:

$$F = \tfrac{1}{2}(\varkappa_1 - \varkappa_2)\, A\, H^2$$

Instead of F we can substitute wg where w is the apparent change in weight in grams. (F is in dynes).

$$\varkappa_1 = \varkappa_2 + \frac{2\, w\, g}{A\, H^2}$$

Now $\varkappa = \chi\rho = \chi \frac{W}{Al}$ where ρ is the density and W the weight of the specimen.

$$\therefore \chi = \frac{(\varkappa_2 v + \frac{2wgl}{H^2})}{W} \qquad (3)$$

For air $\varkappa_2 = +0{\cdot}029 \times 10^{-6}$ and for nitrogen $\varkappa_2 = -0{\cdot}0004 \times 10^{-6}$. Thus if the experiment is carried out in an atmosphere of nitrogen the term $\varkappa_2 v$ is so small as to be negligible and (3) reduces to:

$$\chi = \frac{2wgl}{WH^2} \qquad (4)$$

However in most cases it is inconvenient to use nitrogen, and the $\varkappa_2 v$ term is no longer negligible. For simplicity (3) is reduced to

$$\chi = \frac{\varkappa v + \beta w}{W} \qquad (5)$$

In practice, apart from metallic substances, it is not possible to obtain a cylindrical specimen and it is therefore necessary to powder the substance and pack it into a glass tube, making a correction for the magnetic effect of the glass.

A convenient form of the apparatus is illustrated in Fig. 1. This consists of a semi-micro balance, from the left hand pan of which the specimen is suspended, and a magnet whose position can be varied. The specimen and suspension are surrounded by glass to exclude draughts and a thermometer is arranged to give the temperature near the specimen.

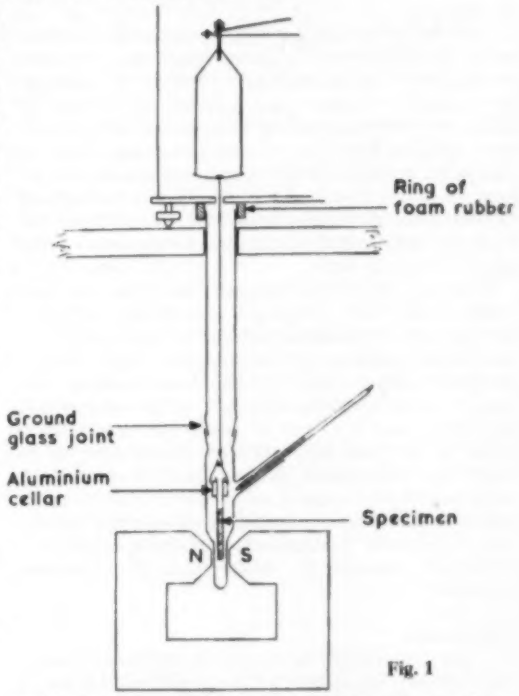


Fig. 1

The tube is suspended from the balance pan by means of a nylon thread and an aluminium collar, and hung so that, when the magnet is in position, its lower end is in the region of uniform maximum field while it is sufficiently long for the top to be effectively outside the field.

The Balance

It is preferable to use a centre-zero, semi-micro balance with a damping device and projection reading, capable of weighing to an accuracy of $\pm$ 0·00002 g., although for teaching purposes a less accurate model may be adequate. Balances specially adapted for the purpose are available from the manufacturers but, if it is desired to convert a conventional model, this can be done by boring a hole of $\frac{1}{2}$ in. diameter in the base of the balance case directly under the centre of the left hand pan and a small hole (say $\frac{1}{16}$ in. diameter) in the centre of the pan itself.

Because of the vertical displacement of the specimen which occurs when weighing it is advisable to have a balance with a rider adjustment on the beam so that the specimen's position in the magnetic field remains unaltered during weighing. The importance of this depends on the characteristics of the magnet, in particular on the extent of field uniformity at the centre of the pole gap and also on the distance to which the field spreads before falling off to zero. In most cases a displacement of the order of a few millimetres, which is liable to occur when weighing without rider adjustment, produces a serious change in ($H_1^2 - H_0^2$) and consequently makes such an adjustment essential.

The Magnet

The requirements of the magnet in this apparatus are that it must give a field of at least 4,000 oersteds with a pole gap of not less than $\frac{1}{2}$ in. (in fact a pole gap so small is very inconvenient; $\frac{3}{4}$ in. is far better particularly for measurements on solutions), and that the field must be uniform within a few oersteds over an area at the centre of the gap of at least $\frac{1}{4}$ in. diameter.

Permanent magnets are obtainable which meet these requirements quite well and because of their simplicity and economy are usually preferable to electromagnets where it is only necessary to make measurements at room temperature. It is only if a temperature variable set up is required that the large pole gap necessary to accommodate the cryostat make an electromagnet essential. The main disadvantage of a permanent magnet is that it does not permit measurements at different field strengths, making it impossible to detect traces of ferromagnetic impurities (whose susceptibilities are field dependent).

As the specimen must be weighed with and without the application of the field to obtain w, provision must be made to move the magnet away. This can be achieved either by mounting the magnet on a trolley with a screw mechanism or by hinging it to the floor and swinging it away.

The Specimen

This is accommodated in a flat bottomed glass tube 7 to 10 cm. in length and about 3 mm. internal diameter for solids or about 1 cm. for solutions. In the case of solids the packing of the tube is of the utmost importance because it is in this that the main inaccuracy of the experiment lies. The specimen must be uniform and, to achieve this, it is important that the solid be first powdered as finely as possible. It is then introduced into the tube a little at a time and after each addition the tube is tapped on a hard surface before more powder is added. If a rigid procedure is adhered to, relatively uniform packing is possible with a little practice.

The Suspension

The specimen tube should be lipped slightly at the top and held by an aluminium collar. This can then be suspended from the balance pan by means of a nylon thread and a small copper wire hook.

It is of course important that the suspension be shielded from all draughts and for this reason the specimen and suspension must be totally enclosed. Glass tubing of 2 to 3 cm. diameter can be used to effect this and should be fitted flush with the bottom of the balance case by means of a ring of foam rubber. The lower end of the tubing must be tapered to fit within the pole gap of the magnet and a thermometer is attached by means of a side arm as near the specimen as possible. To facilitate easy removal of the specimen it is best that the enclosing tube be fitted with a ground glass joint (B24 or B29) just above the top of the specimen tube so that the upper portion may be permanently fixed and the lower portion detached.

Calibration

Unless the characteristics of the magnet are accurately known it is first necessary to determine what length of specimen is required. To do this it is best to use a solution of a paramagnetic salt—ferrous ammonium sulphate is as good as any.

The empty tube is first weighed without the field (that is with the magnet swung, or wound, away) and then in the field (the vertical plane of the tube central with respect to the pole gap and the base of the tube also central). A loss in the weight apparently occurs because of the diamagnetism of the glass. A small amount of solution is now introduced, the height noted and the above weighings repeated. This procedure is continued and a graph of change in weight (with and without the field) against the height of the solution is plotted.

A typical graph is illustrated in Fig. 2. The lower flat portion indicates the uniformity of the field at the centre of the pole gap and the upper flat the limit of the field. In the case in question a 5 cm. length of specimen is shown to be adequate and the tube should be marked at this length.

The next step is to determine the volume of the tube up to this mark and this is most easily done by noting, by difference, the weight of distilled water required to fill it to the mark. Knowing the temperature the

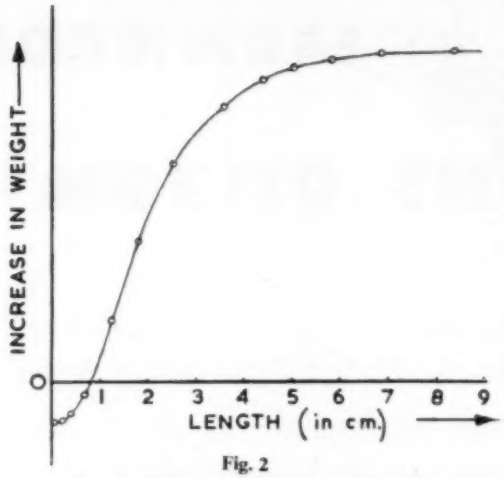


Fig. 2

volume is readily obtained. This gives the value of the term $\varkappa v$ and it is now necessary to evaluate β to complete the calibration. This is done by using a substance of known susceptibility and substituting in (5). The most convenient calibrants are $NiCl_2$ solution and Hg $[Co(CNS)_4]$. The susceptibility of $NiCl_2$ solution has been determined accurately by Nettleton and Sugden[4] and for temperatures around 20°C. and concentrations of about 30 per cent by weight it is given by:

$$\chi = \left\{ \frac{10030}{T} p - 0{\cdot}72(1 - p) \right\} \times 10^{-6}$$

where p is the proportion by weight of $NiCl_2$ in the solution and T is the temperature in degrees absolute.

The empty tube is weighed with, and without, the field, and these weighings are repeated with $NiCl_2$ solution filling the tube to the mark. w is then the increase in weight noted with the filled tube, plus the decrease in weight of the empty tube, and W is obtained by difference. Substitution in (5) gives β. This is a very good standard if the subsequent measurements are to be on solutions but for powdered solids it may be preferable to use a solid calibrant since in this way errors due to imperfect packing may cancel.

Hg $[Co(CNS)_4]$ is a suitable solid calibrant[1] with $\chi = 16{\cdot}44 \times 10^{-6}$ at 20°C. (decreasing by approximately $0{\cdot}05 \times 10^{-6}$ per degree C. rise). As before the tube is first weighed with and without field and the tube, as described previously, is then filled to the mark with the finely powdered calibrant. The weighings are then repeated to obtain w and hence β. The tube is emptied and the process repeated to obtain a second estimate of β. This is continued until agreement of within 1 per cent is obtained.

Calculation of χ_A and μ

Having found $\varkappa v$ and β, the gram susceptibility of any solid can be determined by following the same procedure as described above for the calibration.

Multiplication of the gram susceptibility, χ, by the molecular weight of the compound gives the molar susceptibility, χ_M. To obtain from this χ_A the atomic susceptibility of the metal ion in the compound, allowance must be made for the diamagnetism of the ligands and other groups present

$$\chi_A = \chi_M - \chi_L$$

where χ_L is the susceptibility of the ligands which, being diamagnetic, is negative in sign. The actual values of χ_L for various groups can be obtained from the standard works on the subject[3,5].

If the metal ion is paramagnetic χ_A is positive and the effective magnetic moment is $\mu_{eff} = 2{\cdot}84\sqrt{\chi_A T}$.

A simple example will perhaps suffice to illustrate these points:

In an experiment to determine the magnetic moment of hydrated copper sulphate a tube was calibrated and it was found that:

$v = 0{\cdot}5722$ ml.

$\beta = 356{\cdot}10^{-6}$

weight of empty tube = 7·26042 g.

loss in weight when field was applied = 0·00173 g.

After filling the tube with the powdered copper sulphate the following readings were taken at a temperature of 17·0°C.:

weight of filled tube with field applied	8·05876
weight of filled tube without field applied	8·04734
∴apparent increase in weight	0·01142
Correction for diamagnetism of tube itself	0·00173
w	0·01315g.

It also follows that W = 0·7869 g.

$$\therefore \chi = \frac{0{\cdot}5722 \times 0{\cdot}029 \times 10^{-6} + 356{\cdot}8 \times 10^{-6} \times 0{\cdot}01315}{0{\cdot}7869}$$

$$= \frac{(0{\cdot}01660 + 4{\cdot}691)10^{-6}}{0{\cdot}7869}$$

$$= 5{\cdot}982 \times 10^{-6}$$

Now the molecular weight of $CuSO_4\,5H_2O$ = 249·7

$$\therefore \chi_M = 5{\cdot}982 + 10^{-6} \times 249{\cdot}7 = 1{,}494 \times 10^{-6}$$

From tables χ_L for the ligands etc. are:

SO_4^{--}	$-40{\cdot}1 \times 10^{-6}$
$5H_2O$	$-64{\cdot}9 \times 10^{-6}$
	$-105{\cdot}0 \times 10^{-6}$

$$\therefore \chi_{Cu} = (1494 \times 105)10^{-6} = 1599 \times 10^{-6}$$

$$\therefore \mu_{eff} = 2{\cdot}84\sqrt{1599 \times 10^{-6} \times 290{\cdot}2}$$

$$\therefore \mu_{eff} \approx 1{\cdot}94 \text{ B.M. at } 17{\cdot}0°C.$$

REFERENCES

[1]Figgis, B. N. and Nyholm, R. S. (1958), J. Chem. Soc. 4190.

[2]Gouy, L. G. (1889). Compt. rend. **109**, 935.

[3]Lewis, J. and Wilkins, R. G. (1960). 'Modern Co-ordination Chemistry' Interscience Publishers, London.

[4]Nettleton, H. and Sugden, S. (1939) Proc. Roy. Soc. A173, 313.

[5]Selwood, P. W. (1956). 'Magnetochemistry' Interscience Publishers, New York.

Contributed by **ELGA PRODU**

APPLICATIONS OF ION EX

The complete Chemical Purification of water by deionisation is now widely accepted as an invaluable technique for laboratories and many industrial applications. Other applications of ion exchange are, perhaps, not so well known, and some are now briefly described.

RECOVERY OF ACIDIC CONSTITUENTS

Anion exchange resins have made possible the recovery of many acidic materials formerly wasted. The anionic products are first adsorbed on the resin from solution, then flushed off with an appropriate regenerant. Anion exchange resins can also be used to adsorb acids selectively from mixtures, so that certain acids may be isolated. Among acidic constituents recovered are Amino Acids from distillers solutions, etc., Citric and Ascorbic Acids from Citrus wastes, fatty Acids from soap wastes, Tartaric Acids from Wine residues and Nicotinic Acid from vitamin production wastes.

ADJUSTMENT OF METAL ION CONCENTRATION

Analytical Chemistry often requires specific ions to be added to a solution. An example is the purification of cobalt nitrate solutions. For this, a cobalt form of a cation exchanger is used. Unwanted cations in solution are adsorbed by the exchanger which liberates an equivalent quantity of cobalt ions. Other uses of this application are in Hydroponics (the science of soilless growth) and synthesis of salts.

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CHANGE

Part of this information has been condensed from Rohm and Haas Publication IE-3-53a.

In following issues it is hoped to deal with one or more of these applications specifically.

Elgastat Deionisers are contributing to Research throughout the world by providing ultra-pure water at a turn of the tap.

FRACTIONATION OF IONIC CONSTITUENTS

Methods have been developed to take advantage of the fact that the affinity of exchangers for ions varies with the nature and size of the ion. For example, it is possible to separate anions of strong acids from those of weaker acids. The separation of hydrochloric acid (strong) from hydrocyanic acid (weak) is a good illustration of the fractionation procedure. Passage of the mixture of acids over a column of anion resins, results first in the adsorption of both acids, and as passage continues, pure hydrocyanic acid appears in the effluent. Fractionation in this way permits separation of Isotopes and Rare Earths, Recovery of Metals from Plating and Smelting Solutions and separation of Ionic and Non-Ionic compounds.

ANALYSIS

In chemical analysis, the use of ion exchange resins is widespread, and new problems are being solved daily with its aid. Examples are too numerous to mention, but it is worth noting that ion exchange resins are being used as 'selective sponges' in the estimation of materials occurring at extremely low concentrations. Copper in milk, to cite one case, can be easily determined.

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P.62718

VARIATIONS AND ERRORS IN EXPERIMENTAL INVESTIGATIONS

by S. Lewin, M.Sc., Ph.D.

Physical Biochemistry Research School, South-West Essex College of Technology, Forest Road, London, E.17.

PART II—COMPROMISE ERRORS

EXPERIMENTAL investigations often require conditions and specifications many of which have to be applied concurrently. In some cases these requirements can be met without any conflict. However, a conflict often does take place and as a result some compromise has to be reached between the various requirements. These vary with the type of investigation; sometimes they vary from one stage of the investigation to another. Indeed the occasion arises where the original requirements change with the stage of the investigation to such an extent that either the particular chemical tool or the procedure adopted are no longer satisfactory. As it is not always possible to meet all the individual requirements, the final arrangements represent a compromise. Such compromises may work comparatively well provided the associated limitations are strictly observed. They do, however, increase the possibility of error in two ways. First, it is not always convenient or even possible to ensure that all the various restrictions are rigorously obeyed at all times and at all stages. Second, the introduction of new factors under a new set of conditions often overlooks, at any rate initially, latent sources of errors. These may not be discovered until the investigations are completed and sometimes even published. The history of scientific research contains many such examples. It is not possible to eliminate all such sources of error, but it is hoped that the tracing of the origin and development of some 'compromise' errors undertaken in this paper will assist the early recognition of these in future investigations and in routine laboratory work, and thereby save erroneous conclusions, waste of time and aggravation.

One category of the compromises achieved relies on the utilization of simultaneous and associated variations of a given property of the system examined.

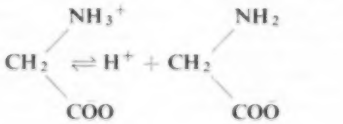
Consider, for example, the use of glass as a container for solutions the conductivities of which are to be measured at various temperatures. As the measurements at high temperatures involve a risk of some strain in the glass vessel and as, despite careful cleaning of the vessel, there is a possibility of leaching of sodium ions from soda glass, it is best to carry out the measurements in a silica vessel. Unfortunately, the cost of silica vessels is rather high and the platinum required for the conductivity measurements cannot be sealed into such vessels.

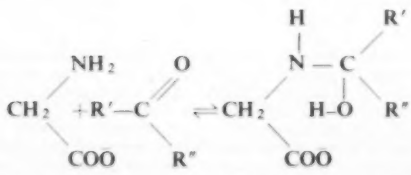
As a compromise one uses a high resistance glass such as Pyrex into which it is possible to seal platinum, though not as satisfactorily or easily as in the case of soda glass. This is due to the coefficient of expansion of soda glass having almost the same value as that of platinum, while that of Pyrex is a little lower. The Pyrex-platinum seal is by no means ideal, and requires that the diameter of the sealed portion of the platinum wire be comparatively small. Provided that the temperature variations are not too high the seal remains intact. However, the diameter of the part of the platinum wire supporting the black platinum electrodes cannot be made very small because of mechanical strength requirements. Unfortunately, it does happen sometimes that the conductivity cell, after being washed, is shaken not too gently in order to remove the last adhering drops with the result that some slight alteration in the dimensions of the cell takes place. This results in the cell having a slightly different cell constant value and therefore introduces an 'experimental error' which may be discovered only after a number of measurements have been taken. The error cannot be always ascribed solely to lack of care; rather it is partly due to a change of apparatus necessitating a change in an established experimental procedure, as the original measurements had been taken using a soda glass—platinum seal when the method was perfectly satisfactory, as only a range of 20°C.—40°C. was involved and the original platinum wire was much thicker.

One major contribution towards the compromise reached is that of time. It has already been pointed out in Part I of this series that time limitations alone make it difficult, if not impossible, to obey the axiom of never taking anything for granted in scientific work. In an effort to overcome the time factor one attempts to automate as far as possible various stages of the routine work or of the investigation. The use of automation instruments is justified, because they decrease the number of 'personal' errors. However, it should not be forgotten that, unless carefully operated, they may give rise to 'apparatus' error, which is sometimes more difficult to trace than the personal error. Familiarity with the apparatus and the employment of specially qualified laboratory technicians decreases the possibility of 'misbehaviour' of the instrument, but does not necessarily affect the errors inherent in the construction of the instrument. Sensitivity and accuracy as well as time saving are often accompanied by increase in cost. Financial considerations are often the limiting factor, with the result that the limitations of the investigation and possible errors are controlled by the compromise between time and finance.

Such limitations and associated errors or experimental variations are usually recognizable from the onset of the investigation. Once the apparatus and techniques and regular checks have been established, it is unlikely that considerable variations and errors will be encountered. On the other hand there are fields in which considerable variations may be encountered, e.g. in the biological field, where the term 'biological variations' sometimes covers totally opposed results or interpretations.

Problems involving sperm motility may be used in illustration. Mammalian sperm motility is affected by the pH value of the suspension medium, and at pH values above 9 and pH values below 4 little motility is usually encountered. In order to measure quantitatively the effect of pH on sperm motility it is desirable to use a suspension medium in which sperm lifespan is prolonged. One may use a salt balanced buffered solution (A) such as that containing NaCl, KCl, $CaCl_2$ and glycine (Schröder, 1941) and adjust the pH to various values as required. However, the lifespan of sperm has subsequently been shown to increase in presence of fructose or glucose. Consequently, one of these is added to the buffered medium (A) and the pH is determined. The pH is recorded, the sperms are suspended, and the proportion of motile sperm and the degree of motility is assessed. Sometimes all these stages are carried out within two or three hours, sometimes a stock solution of suspension medium is used the day after it has been prepared and its pH measured. The motility results are plotted against the corresponding pH value, but the results appear to show no degree of order. When the results are contrasted with the control series—without the hexose—it is readily seen that the latter are far more orderly. The apparent lack of order might have been attributed to 'biological variations'. Fortunately the explanation is a simple one. The glycine anion reacts with the added hexose and this results in a pH depression according to the simplified scheme (Lewin, 1956a, 1956b):





With fructose there is an induction period of one day; with glucose the reaction proceeds immediately but takes about two days to reach equilibrium. Unless the pH value is recorded when equilibrium has been established, various *intermediate* values are noted. It should also be remembered that if stock solutions are kept for any length of time it is essential to determine whether the first steady pH state or subsequent steady pH states have been reached, because pH values and possibly glucose utilization are affected.

The elimination of leakage in volumetric determinations requires a compromise between accuracy, time saving, cleaning convenience and cost. Several compromises are known. One is to use a well-fitting all-glass stopcock sealed on to the bottom of the burette. The stopcock must of course be thoroughly cleaned and subsequently covered with a fine layer of semi-solid lubricant. Originally vaseline grease was used, and it was found to be generally satisfactory except when titrating slowly with strong oxidizing agents. Some variations were then encountered which could be traced back to some oxidation of the vaseline. As the normally unoxidizable silicone greases became commercially available they were substituted for vaseline. In the beginning they seemed quite satisfactory. However, some variations in large titration values (amounting to almost the full range of the burette) were soon noted and these were readily traced to the creeping of the silicone grease up the burette which affected the values of the reading (by affecting drainage). The silicone grease could not be easily removed by the standard cleaning methods and required special cleaning techniques (Lewin, 1957). Thereupon vaseline was resubstituted, and the oxidizing agent was placed in the titration vessel instead of in the burette. This method is not always convenient so far as end-point determinations are concerned, e.g. when a strongly coloured oxidant is used and the end-point is characterized by a colour change, such as is the case when permanganate is used. Experience does show that complete oxidation of the reductant can be more accurately assessed on the appearance of colour rather than on its disappearance. On the other hand, the error introduced by slow reduction of the permanganate, if in contact with the layer of grease on the stopcock, cannot be neglected when a high degree of accuracy is considered essential.

The type of burette in acid-base titrations can also give rise to variations which are associated with the particular compromise used. If a soda-glass burette is used, the probability of attack on the glass when sodium hydroxide is used is considerably increased; careful restandardizations show this time and again. Also the stopcock tends to seize unless cleaned and regreased regularly. One solution is to place the sodium hydroxide in the titration vessel, but this compromise may well lead to serious errors as considerable CO_2 absorption is likely to take place. The latter difficulty can be overcome by bubbling an inert gas through the solution. This must be sufficiently rapid not to allow diffusion of air. However, if the flow is too fast, some of the liquid may well be lost as spray.

One solution is to use the recently developed, thoroughly inert, Teflon glass stopcocks which are now commercially available. However, these are far more

expensive than the ordinary all-glass stopcock, and while a few may be bought for research and industry, their wholesale introduction into the Advanced Level, Degree and Higher qualification courses is financially rather prohibitive.

Let us consider now other facets of compromise which arise from other factors than those associated with the use of apparatus or experimental technique. In scientific investigations it is often necessary to strike a compromise not only between the various requirements of different aspects of the experimental technique itself, but also to allow for human frailty.

Human frailty involves the possibility of erroneous formulation of the problem under investigation, and this may well raise the probability of error to a high degree. This facet is very important and because of this the implications will be considered in a separate paper in this series. Here we shall concern ourselves with errors which arise from the execution of the project rather than from its formulation.

Mathematically there exists a distribution curve for any particular factor or for a combination of factors. The probability of avoidance of errors depends not only on the apparatus and the experimental technique adopted, but also on the personnel involved.

Training or high qualifications are not absolute guarantees against personal susceptibility to errors or variations. Bitter experience shows that laboratory or research personnel may be 'accident-prone'. They may also be 'error-prone'. There are some who combine, in a particular laboratory, accident-proneness with error-proneness. They represent a menace in the laboratory and must be removed before managing to wreak irreparable havoc. One might ask in amazement how such personnel ever managed to obtain the necessary qualifications and the particular appointment. The answer is that the mathematical probability of this taking place is increased considerably when a combination of circumstances is encountered. The law of supply and demand operates at present in favour of 'risky' employments, and hence the probability of employment of 'prone' personnel is bound to be higher than when selection is greater. 'Prone' persons may decrease their accident- and error-proneness, provided that they have sufficient determination. However, the above law does not encourage determination in present 'surplus of posts' conditions, but rather encourages parasitism. The employment of such 'prone' personnel, by increasing the probability of uncertainty and worry in other personnel, enhances general accident- and error-proneness in the laboratory. The mental relief achieved when such prone personnel have left the laboratory for good can be truly heartfelt.

The probability of decreasing the numbers of variations and errors increases with the determination and ability of the experimentalist. Such determination is essential for the prosecution of the project. However, there are times when one must put aside one's determination and give way graciously when a combination of circumstances may be temporarily overwhelming. Such a combination may be associated under the term 'bad day' or 'bad luck'. Very occasionally one encounters a day when everything appears to go wrong. Several glass vessels are broken, end-points that should be equal differ significantly more than the usual experimental variation, the automatic electronic recorders do not function properly, and even the calculating machines give clearly erroneous results. Given sufficient time and patience, the 'hoodoo' which appears to have descended on the laboratory may be coldly and accurately analysed. However, as the causes may be primarily personal or merely human, it is often the best policy not to dissipate time and energy on such an analysis, but rather to classify the phenomenon as a 'bad day' and, if the investigation permits, to absent oneself from the laboratory for the day. This compromise, by avoiding worry, should assist in reducing any latent proneness to accidents and errors.

The problem of personal errors, which is partly associated with compromise errors, has far wider implications and will therefore be considered separately in this series.

REFERENCES

Lewin, S. (1956a). Biochem. J., **63**, 14.
Lewin, S. (1956b). Biochem. J., **64**, 30 p.
Lewin, S. (1957). Lab. Practice, 213.
Schröder, V. N. (1941). Tierzucht. Zuchtungsbiol., **50**, 1.

Recent British Standards

Laboratory Evaluation of Disinfectant Activity of Quaternary Ammonium Compounds by Suspension Test Procedure

The purpose of this British Standard, which is based on a procedure developed by the British Disinfectant Manufacturers' Association, is to enable a similar method to be used in every laboratory evaluating the disinfectant activity of quaternary ammonium compounds and their formulations (B.S.3286:1960, price 6s.).

Essentially the prescribed technique comprises adding a suspension of viable micro-organisms to solutions containing one or more concentrations of quaternary ammonium compound, and determining the numbers of organisms surviving after a period or periods of time. Within this general framework, the test conditions may be selected for any particular purpose. The procedure may be used, for example, as a screening test to compare the activities of quaternary ammonium compounds under specified conditions, either in the presence or in the absence of added organic matter; to compare the activities of quaternary ammonium compound formulations at the recommended dilutions for use; or as a screening test against a range of organisms. Detailed examples of such tests are given in an appendix to the standard, the results being presented graphically.

The various steps in the experimental procedure are specified and the precision, presentation and interpretation of the results are discussed. It is emphasized that the results may apply only to the particular conditions of the test used and should not be interpreted as an absolute measure of disinfectant activity. As an aid to the design of particular tests, guidance is given on such matters as suitable test organisms, the preparation of cultures and the choice of range of dilutions, temperature and time of contact with the organisms.

Copies of this Standard may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1.

ELECTRONICS FOR BIOLOGISTS

by G. C. Ware

Department of Bacteriology, University of Bristol

PART III

Capacitors

Capacitors, originally called condensers, are components of electrical circuits consisting essentially of two conductors, often in the form of plates, separated by an insulating layer. When a potential difference is applied to the conductors a current flows into the capacitor until the conductors reach the same potential difference. No further current then flows and the capacitor is said to be charged. The capacitor will hold this charge, delivering it to any suitable circuit. Capacitors may therefore be used to store small quantities of electrical energy.

Consider the circuit in Fig. 17 which shows a capacitor, a battery to provide charging voltage, a resistor (R_1) to limit the charging current and slow down the charging process so that it may be observed on the milliammeter, which measures the charging current, and a voltmeter which measures the voltage to which the capacitor is charged. A two-way switch is provided so that the capacitor may be slowly discharged through R_2.

When the capacitor is connected to the charging battery (B connected to A), the meter indicates a current flowing into the capacitor, and the voltmeter starts to rise also. As the voltage of the capacitor rises, so the potential difference between the capacitor and the battery becomes less and therefore the current flowing through R_1 becomes less.

$$I = \frac{E(batt) - E(cap)}{R_1}$$

In this way the capacitor will never be quite fully charged nor the charging current quite zero, but continuously diminishing. (Fig. 18*a* and *b*). By removing the limiting resistor, the whole process will, of course, be speeded up though the charging curves will be similar and charging never quite complete.

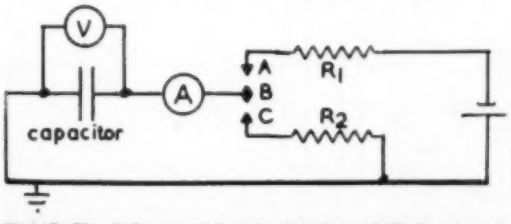


Fig. 17. Circuit for examining the charging and discharging of a capacitor. The capacitor will charge when B is connected to A and discharge when B is connected to C. The current flowing and the voltage of the capacitor are indicated by the two meters.

If when the capacitor is charged the switch is moved to the lower position (B connected to C Fig. 17) the capacitor will discharge through R_2, the current being high at first whilst the capacitor is highly charged and falling as the voltage of the capacitor falls. In this type of circuit the capacitor will, of course, never completely discharge. The process of charging and discharging can be repeated over and over again.

Let us suppose that instead of charging the capacitor from a battery a variable charging voltage is connected directly to the capacitor and the voltage is gradually increased, one plate being made progressively more positive (Fig. 19). As there is no resistor in the circuit, charging will be rapid and current will flow for only a very short time after each increment of applied voltage and the voltage of the capacitor will always almost equal the charging voltage. As the charge voltage is lowered again the capacitor, now having a higher voltage than the charging source, will discharge through the source and the current will flow in the opposite direction until the voltage of source and capacitor are almost zero. If now the process is repeated, current will again flow first one way then the other. Provided, therefore, that the applied voltage is always changing, current will flow in the circuit but when the applied voltage remains constant the capacitor will rapidly come to equilibrium with the charging voltage and current will cease to flow. It is possible therefore to use a capacitor to pass *varying* voltages or currents and hold back *steady* ones and thus to act as an electrical *filter*. This filtering action is the primary use of capacitors in electronics.

Commercial Capacitors

Capacitors vary in size according to the quantity of electricity they can store. This *capacity* is measured in

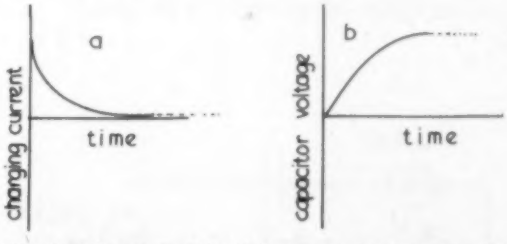


Fig. 18. When a capacitor is first connected to a potential difference the flow of current into the capacitor is high (*a*) but falls as the voltage of the capacitor rises to equal the charging voltage. The current therefore will never actually reach zero. In a like manner (*b*) the capacitor voltage rises fast at first, then more slowly finally asymptoting to the charging voltage.

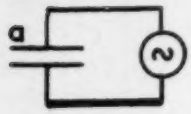


Fig. 19. Because of alternate charging and discharging when connected to a variable charging voltage a current appears to flow through a capacitor. In fact no electrons pass between the plates.

Farads, more usually in microfarads μF. (1. F. = 10^6μF) and picofarads (F = 10^{12}pF.). Also, the insulating layer between the two conductors must be adequate to prevent electrical leakage between them and the thickness of this insulation has a marked effect on the size and price of a capacitor. Capacitors are, therefore, made with a nominal capacity and a maximum permissible applied voltage. Small capacitors from 1 pF to 1,000 pF are usually available according to a system of preferred values and tolerances similar to those for resistors. They are usually designed to stand 1,000 V. as less insulation would not produce substantial saving in size or price. Larger capacitors up to 1 or 2 μF. are available in various voltages and most commonly in a scale of 1 and 5 thus: ·001 μF., ·005 μF., ·01 μF., ·05μF., etc. Conventional capacitors of capacity greater than 1 μF become exceedingly bulky and expensive and special types known as *electrolytic capacitors* are usually used being cheaper and smaller. These generate their own insulation by electrolytic action. They may only be used on direct current and must be connected with correct positive and negative connections, and, unlike conventional types they pass a small d.c. leakage current. Very high voltage types are not available, 450 V. being the maximum voltage with present designs. Electrolytic capacitors are usually made at doubling intervals, 2, 4, 8, 16, 32 and 64 μF. being the most common values. Low voltage electrolytic capacitors up to 5,000 μF are available.

As capacitors pass electricity by charging and discharging, the current may be considered as being passed in units of one charge per cycle. The size of the charge, directly related to capacity, and the number of units per second (applied frequency) will obviously determine the total current flowing through the capacitor. The higher the frequency the greater the current which will flow through a capacitor of given capacity.

The apparent resistance offered by a capacitor to any varying applied voltage is given by the formula

$$R = \frac{1}{2\pi fc}$$

where R is the apparent resistance of the capacitor in ohms, f the frequency in cycles per second and c the capacity in farads. Since capacitors offer resistance to varying currents they may conveniently be used to produce voltage reductions in a.c. circuits. For example, consider the operation of a 6 V., 0·3 A. bulb from a 240 V., 50 c/s. a.c. mains supply (Fig. 20). The total current flowing in the circuit must be 0·3 A. and the total resistance, therefore, 800Ω, ($I = \frac{E}{R}$). The resistance of the lamp is 20Ω. ($I = \frac{E}{R}$); therefore, the additional resistance required is 780 Ω. The power loss in a resistor will be 0·3 × 0·3 × 780 ($W = I^2R$) W = 70 W. So far, the situation is identical with the earlier d.c. example using a 12 V. battery and 2·5 V. bulb. However, a resistance of 780Ω is offered to a 50 c/s. a.c. current by a capacitor of 4 μF., ($R = \frac{1}{2fc}$).

$$780 = \frac{1}{2 \times 3{\cdot}14 \times 50 \times C}$$

$$C = \frac{1}{2 \times 3{\cdot}14 \times 50 \times 780} = {\cdot}00000408 \text{ F.}$$

$$= 4{\cdot}08 \ \mu\text{F.}$$

Although size for size a 4 μF. capacitor and a 70 W. resistor are very similar, certain phase phenomena associated with capacitors result in the peculiar fact that no power is consumed by the capacitor and so although 0·3 A. are flowing through an effective resistance of 780Ω no heat is generated. Moreover, the total consumption is only 1·8 W. compared with 71·8 W. using a resistor. When using either resistors or capacitors with a.c. mains, care should always be taken to insert the limiting device in the *live* wire, otherwise full current could be drawn from the live wire to earth and dangerous shocks obtained. (Fig. 21.) It is, in fact, immensely preferable always to employ a transformer when using the mains for experimental purposes.

To summarize, capacitors may store small quantities of electricity. They block the flow of direct current, but pass an alternating or varying current in proportion to its frequency and their own capacity.

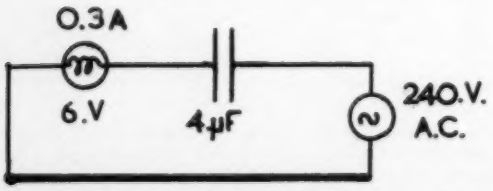


Fig. 20. Use of a capacitor in an a.c. circuit to limit the flow of current through a torch bulb. c.f. Fig. 1.

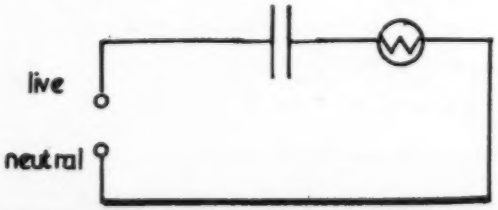


Fig. 21. Care should be taken always to insert current limiting devices, such as fuses, switches and resistors in the live wire of an a.c. supply. If only the neutral is interrupted 250 V. will still appear between live and earth.

MODIFIED MANOMETERS OR VACUUM GAUGES

by M. A. Phillips, D.Sc., F.R.I.C., M.I.Chem.E.

THIS note deals with the two popular types of manometers used for measuring vacuum in, for example, vacuum distillation; the range of accuracy of both is 0·5 to 1 mm. Both are cheap and easy to fabricate.

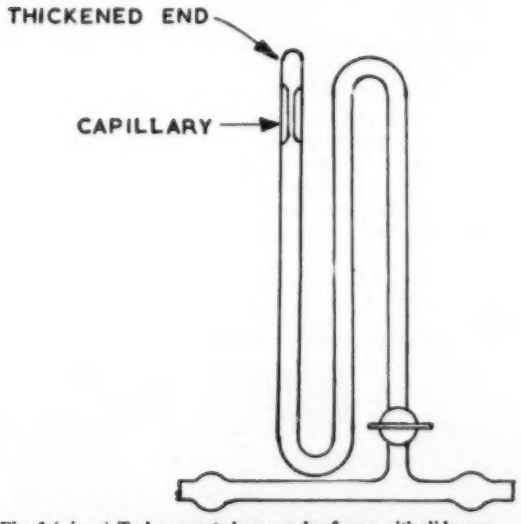
The popular U-tube type of manometer suffers from a number of disadvantages, one of which is inherent in its design and inclines us here to the use of the 'pull-up' type referred to below. This disadvantage is that if any air gets into the Torricellian vacuum, the gauge reads incorrectly and the air must be removed and the mercury purified and de-aerated after recharging. This is a tedious operation but in spite of this, the type remains very popular, probably because it occupies small bench space. There is another disadvantage with this type that can be overcome by proper design. If the cock is opened quickly when the system is at low vacuum or at atmospheric pressure, the mercury will rise rapidly in the closed section and the gauge is very apt to break at the top of the Torricellian vacuum space. This can be overcome by (*a*) using capillary tubing for the apparatus which is not recommended because it makes emptying, cleaning and refilling difficult, (*b*) using a capillary bore stop cock, which is not recommended because this makes the readings sluggish on any change of the vacuum or (*c*) the device described below.

We recommend that a capillary section be inserted near the top of the Torricellian vacuum space, as shown in Fig. 1, and that the end of the tube be thickened to withstand physical shock; the first device alone would probably serve to avoid breakage, even if the stop-cock is opened suddenly at atmospheric pressure.

To avoid oxidation of the mercury, a little syrupy phosphoric acid may be introduced over the surface of the mercury as shown. This is optional in the case of the U-tube type of gauge but, in our opinion, very necessary with the pull-up type referred to below. The capillary device has been tried in a number of laboratories and can be confidently recommended.

The pull-up vacuum gauge is very easy to make and is very popular as it is foolproof and practically breakage proof. One disadvantage is that to read it, the atmospheric pressure in the vicinity must be known at the time and this necessitates either a mercury (Fortin) barometer or communication with a meteorological station at the time of reading. The latter course is not very onerous, especially if the gauge is not used very often.

Although this type of gauge can be, and often is, used in the laboratory, it is also commonly used for



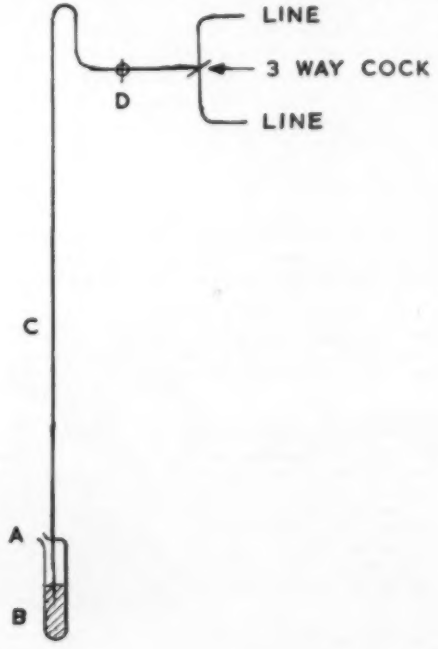


Fig. 1 (*above*) **To be mounted on wooden frame with slide mm. scale (not to scale).**

Fig. 2 (*right*) **A-Filler orifice; B-Mercury reservoir; C-Gauge tube; D-Stopcock.**

works vacuum distillations and is preferred by many to clock gauges, however accurate or well made. This simple cheap gauge is preferable even to the Edwards clock gauge which is quite an accurate but much dearer instrument. It is quite practicable to have a Fortin barometer installed in the vacuum distillation shop in which a number of pull-up gauges are in use and this is quite common practice.

A further disadvantage, especially in work-shops where it is not so easy to ensure cleanliness as in a laboratory, is that the mercury in the tube and in the reservoir (Fig. 2) oxidizes rapidly giving a dirty meniscus and a dirty tube which is difficult to read.

This difficulty is completely overcome by having a thin layer of syrupy phosphoric acid over the mercury surfaces; this protects against oxidation, leaves clean glass and does not sensibly affect the accuracy of the readings which remain accurate to about 1 mm. or, with a magnifier, to about 0·5 mm. This is sufficient for the general purposes for which the instruments are used. It is not necessary to do more than place a layer of the acid over the mercury in the reservoir before first use as this is then pulled up with the mercury and gives the layer needed over the mercury in the column. If a weaker phosphoric acid is used, the water is distilled off from that in the column during use under vacuum and, after a short time, accurate readings are possible.

We have known cases in which a gauge so made has remained clean even in a dirty work-shop, for over 12 months.

If phosphoric acid is not used, the gauge tube must be of wide bore (about $\frac{1}{4}$ in. minimum) to make the frequent cleaning necessary less onerous, but if the protecting layer of acid is used much narrower bore tubing can be used thus economizing in mercury. This reduces the cost of the apparatus, especially as a smaller reservoir is also feasible. We recommend a bore of 1·5 mm. inside and the use of moderately thick walls for the gauge tube.

In addition to vacuum distillations, there is a wide use for this type of gauge in ampoule filling under vacuum, and especially in the manufacture of ampoules filled under vacuum conditions.

DEVICE FOR THE DIRECT MEASUREMENT OF BISCUIT DIMENSIONS

by B. Francis and C. H. Groves

British Baking Industries Research Association, Chorleywood, Rickmansworth, Herts.

THE baking technologist is very interested in biscuit dimensions. In biscuit baking experiments they are frequently the only objective means of assessing results. The need arose to measure the thickness and the diameters, parallel and at right angles to the production line, of all sizes and shapes of biscuit.

The present device (Fig. 1, 2 and 3) uses micrometers. The central turn-table rotates by hand and, after turning through 90° from a locked position, is held in position again at the end of the quarter turn by a spring loaded ball and socket catch. The sockets are made in the wide shaft carrying the turn-table.

To the right of the turn-table is the bench micrometer assembly. This slides along a rail and is clamped on it in the position most convenient for the particular size of biscuit being measured. This assembly carries the micrometer itself and the extension arms and rod which extend over the turn-table, the left-hand extension arm carrying a round machined end-piece. The micrometer itself carries a similar right-hand end-piece.

These end-pieces are in contact with the biscuit when taking a measurement. The right-hand end-piece rotates with the micrometer and, the biscuit being held against the left end-piece, the exact moment of contact is immediately apparent because the rotation of the end-piece just begins to move the biscuit out of alignment.

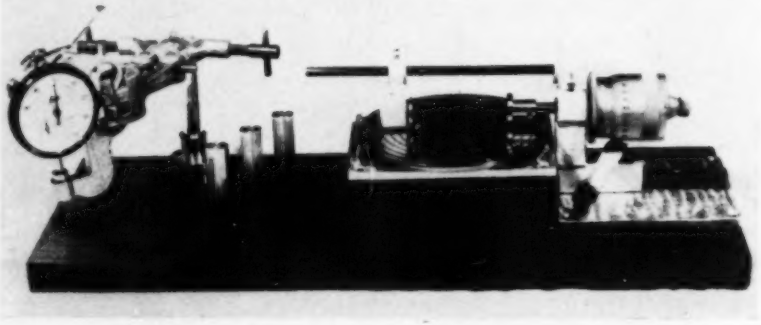


Fig. 1. Biscuit measuring device—complete assembly.

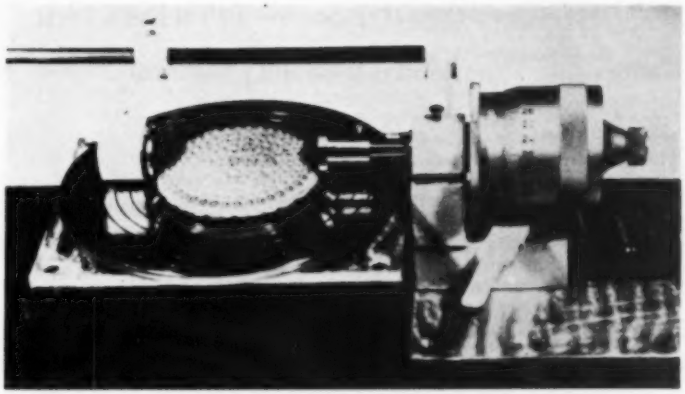


Fig. 2 (*right*) **Turn-table and bench micrometer assembly with biscuit in position for diameter measurement.**

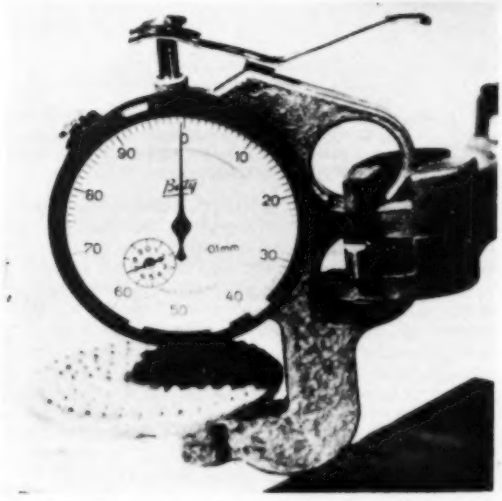


Fig. 3 (*below*) **Dial micrometer with biscuit in position for thickness measurement.**

In this way there is no erosion or compression of the biscuit edge and exact measurements are taken.

To the left of the turn-table is the dial micrometer. This model is fitted with a spindle-lifting lever for raising and lowering the spindle under spring pressure. Both dial and bench micrometers are calibrated in millimetres.

In operation the distance apart of the end-piece has to be accurately set according to the diameter of the biscuit to be measured. The bench micrometer is set to zero and the appropriate standard length, e.g. 55 mm., is placed between the end-piece and the left-hand extension arm clamped into place on the extension rod when the two end-pieces are in correct contact with the standard length. Three standard lengths are shown in the photograph.

Biscuits to be measured are always greater in diameter than the standard length used. When a biscuit is placed on the turn-table its diameter is measured by winding out the micrometer and then winding in until contact is made as described above. Biscuit diameter is then standard length plus bench micrometer reading. After rotating the turn-table the other diameter of the biscuit is similarly measured. Thickness is measured by raising the spindle of the dial micrometer and placing the biscuit on the lower anvil. On releasing the spindle the thickness is read directly. Both the diameter and the thickness are read to the nearest 0·1 mm.

The present device has been tried out on some 2,500 biscuits from baking trials. Compared to a previous device, using an interrupted parallel light beam, it has proved more easily used, robust, easily assembled and dismantled, and portable. It is capable of measuring any size or shape of biscuit from 2 to 12 cm. in diameter and from 0 to 1·2 cm. in thickness. Where a biscuit has two widely differing longitudinal axes or diameters two standards are set up and the procedure is to measure one axis using one standard, reverse the pile of biscuits, re-standardize and measure the other axis. If individual weights of biscuits are taken at the same time as dimensions, then weight and one axis are recorded together followed by thickness and the other axis. Further models will be built and may incorporate dial micrometers for diameter readings as well as for thickness.

LABORATORY APPARATUS AND MATERIALS EXHIBITION

The second national Laboratory Apparatus and Materials Exhibition will be held in the Royal Horticultural Society's New Hall, Westminster, from June 19-22, 1961.

Sponsored by *Laboratory Practice*, the exhibition is being held so that manufacturers of apparatus, materials and other products specifically produced for laboratories can show their equipment to scientists and laboratory executives in industry, research, education, medicine and national and municipal government. It is expected that every possible type of laboratory requirement will be shown and demonstrated during the four-day exhibition. Both British and overseas equipment will be shown and many overseas buyers are expected to attend.

HIGH FREQUENCY TITRIMETER TYPE HFT 30 C

A new laboratory apparatus of wide application

Constructional Details and Technical Measuring Data

The high frequency titrimeter HFT 30 C is a joint development of the Physikalisch-Chemischen-Institut of the Bergakademie Claustal (Prof. Dr. K. Cruse) and the Wissenschaftlich-Technischen-Werkstätten, Weilheim/Obb. (Dr. Habil.K. Slevogt).

The apparatus has an operating frequency of 30 mc/s ± 1 per cent and can be used for high frequency titrations and conductance measurements. The drive for the tuning capacitor incorporates a precision dial with 4,500 graduations and this feature, together with the built-in indicating meter with scale length of 15 cm., permits measurements to be made according to three different principles, viz:

(*a*) *Reactive Component Method.*[1]—Evaluation of capacitor dial reading after tuning apparatus to resonance.

(*b*) *Energy Component Method.*—Evaluation of meter reading after tuning apparatus to resonance.

(*c*) *Deflection Method.*—Setting apparatus to resonance followed by individual evaluations of resulting readings on indicating instrument.

It is of particular importance to note that the three different measuring procedures mentioned above involve the use of one apparatus only. This follows from the fact that the optimum response sensitivity with so-called 'electrodeless cells' when used for conductance measurements in cells of given construction, using any of the three methods mentioned, is itself a function of the conductance. Thus from Fig. 1 it can be seen that in the region of minimum response sensitivity for the energy components (section a-b), the reactive component effect has greatest sensitivity because the associated curve has maximum slope in the same region.

From Fig. 1 it can be further seen that the titration of diluted as well as concentrated electrolytic solutions is made in accordance with the energy component method (or alternatively the deflection method). The sensitivity gap in the case of medium concentrations can be easily closed by making use of the reactive component procedure. A special advantage of high frequency conductance measurement follows from the fact that not only can practically all 'classical' conductometric titrations be carried out, but in addition measurements are also possible where 'classical' methods can give rise to faults of measurement, e.g. by polarization, incrustation, poisoning, corrosion and catalytic influence of the electrode metal on the solutions to be measured. Faults due to these causes can be eliminated by the use of 'electrodeless measuring cells,' the capacitative electrodes of which are attached to the outer wall of the measuring cell and so do not have physical contact with the substance under test.

Fig. 2 shows the constructional details of the high frequency titrimeter HFT 30 C. The bottom panel is equipped with two control knobs for the adjustment of sensitivity and range respectively. The upper sloping panel incorporates the precision dial of the tuning capacitor (right) and the indicating instrument (left). The measuring cell fits in a

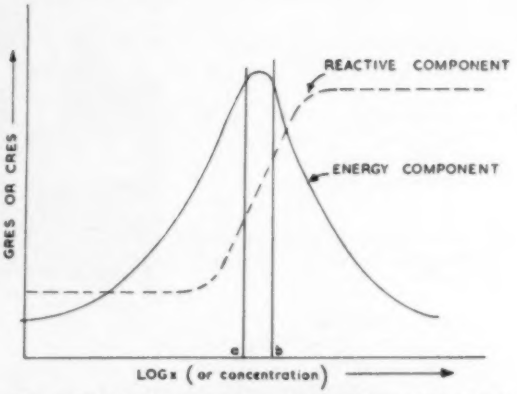


Fig. 1. Relationship between reactive component CRES and energy component GRES for a test solution of conductance x (which varies as concentration) using a capacitative electrodeless measuring cell.

socket provided with a protective metal sleeve. Burette (with titrations) and stirring motor are mounted on a rigid support firmly fixed to the apparatus. It is also possible (e.g. in conductance measurements for kinetic researches) to maintain the test solution at a constant temperature by inserting a temperature coil in the cell. The influence of the temperature coil on the damping of the measuring loop can be ascertained and allowed for by filling the measuring cell with solutions of known conductance. In addition to this cell, which uses approximately 50 ml. of solution, special cells of Condensa are also available for carrying out micro- and semi-micro titrations using approx. 8 ml. of solution. When necessary, temperature control can be attained by immersing the outer surface of the cell in paraffin oil.

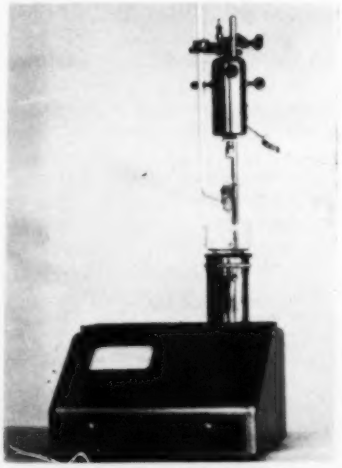


Fig. 2. Titrimeter HFT 30 C.

[1]The expression 'Reactive Component Method' is used here if the variable tuning capacitor in the measuring apparatus is altered and the graduations of the associated precision dial read. There is no strict definition for this designation.

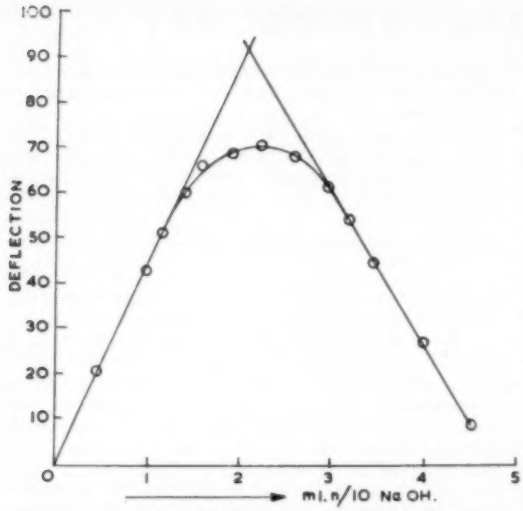


Fig. 3. Titration diagram for 10 mg. sulphuric acid in 50 ml. 3n acetic acid according to deflection method. A = deflection of instrument pointer at 1/1 sensitivity.

For these capacitative cells, the high frequency titrimeter type HFT 30 C was developed. An apparatus for use with inductive measuring cells is in course of development.

Typical Examples of High Frequency Conductance Measurements

1. *High frequency titrations of small quantities of mineral acid in a large excess of organic acid.*—The problem of determining titrimetrically small quantities of sulphuric acid, for example, in a 50 to 100 times excess of acetic acid may be solved only with great difficulty by the old method. Owing to the buffer effect of the acetic acid there are, virtually no sharp neutralization points. In this instance the well-known fact that strong and weak acids are capable of being determined concurrently by conductometric methods can be utilized in a simple manner by means of high frequency titrimetry. Furthermore, with this procedure, the relatively high conductance of the acid mixture does not give rise to disturbances resulting from polarization effects

Fig. 3 shows the high frequency neutralization point for a solution which contains approx. 0·5 per cent w/w sulphuric acid with 50 per cent w/w acetic acid. The use of the deflection method enables the neutralization point to be indicated so sharply, as a result of the reversal of the sign of the measuring unit used for evaluation, that it is not necessary to evaluate the result graphically. In this procedure, with some practice, the titration end-point can be observed visually.

2. *High frequency titrimetrical determination of carbonates.*—The analytical determination of small quantities of carbonate in the presence of large amounts of bicarbonate and hydroxide is difficult, as is well known. With the titrimeter described, however, it is possible by the deflection method, to determine accurately the carbonate in the mixture named, if the titration is carried out as follows:

(*i*) By using barium acetate as titration substance, mobile carbonate ions are exchanged in the course of the titration for acetate ions essentially more difficult to move. As a result an increased conductivity effect is realized.

(*ii*) By adding a 50 to 75 volume percentage of methanol to the test solution the solubility of the barium carbonate is greatly reduced and its tendency towards crystallization increased.

(*iii*) By inoculating the solution with a small addition of freshly precipitated barium carbonate, which to a large extent removes the tendency of the barium carbonate formed during the titration to produce supersaturated solutions.

By paying careful attention to the above mentioned suggestions accurate carbonate titrations have been carried out. Furthermore, by using the deflection measuring

(*Concluded on page 174*)

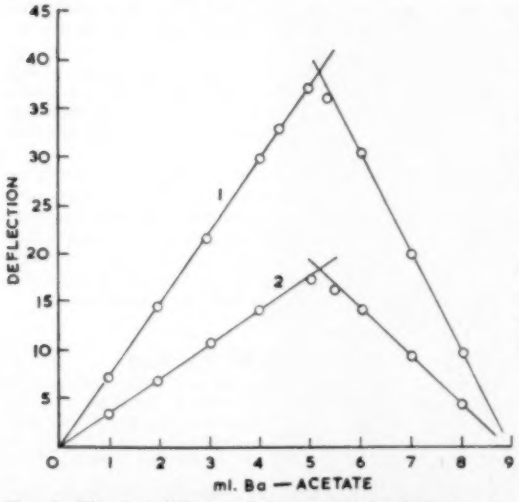


Fig. 4. Titration diagram of 5 ml. approx. 0·1 N soda solution according to deflection method (1/1 sensitivity). 1. Addition of 10 ml. approx. 0·1 N. bicarbonate solution, 10 ml. water and 75 ml. methanol. 2. As above but 10 ml. water replaced by 10 ml. 0·1 N caustic soda.

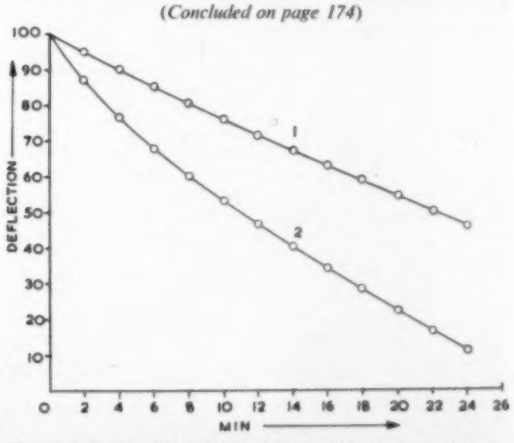


Fig. 5. Decomposition of thiosulphuric acid as measured by the deflection method. Curve 1 = $2 \cdot 10^{-2}$ N thiosulphuric acid Curve 2 = $5 \cdot 10^{-2}$ N thiosulphuric acid.

POLAROGRAPHY IN THE FOOD INDUSTRY

MRS. B. LAMB, in the chair, opened the morning session of the 'All-Day' Polarographic Society meeting on Thursday, January 5, by welcoming the many interested scientists from industry and the Colleges, who had gathered at the S.E. Essex Technical College, Dagenham. The Society was warmly welcomed by the Principal of the College, who said that he valued such contacts with learned societies and with industry.

The first lecture entitled 'The Rapid Estimation of Copper Lead, Zinc and Tin in Foodstuffs by the Cathode Ray Polarograph' was given by Mr. W. F. Condliffe of Heinz Ltd., who gave a most interesting account of the development of suitable methods for the analysis of copper, lead, zinc and tin, based on a single wet oxidation of the foodstuff. He briefly referred to the various methods of ashing and wet oxidation discussed in detail by T. T. Gorsuch (Analyst, 1959, **84**, 135) and gave his reasons for finally choosing to oxidize the food with a mixture of sulphuric acid and nitric acid, completing the oxidation with perchloric acid to remove nitric acid. After boiling with water the sample is cooled and diluted to 25 ml. with water. Portions of this solution are taken and treated chemically to give suitable conditions for polarographic estimation, including the addition of a suitable base electrolyte. After deoxygenation with nitrogen, the samples are examined on the single sweep, linear time base, K.1000 cathode ray polarograph (Southern Analytical Ltd.).

He stressed that for linear calibration curves (for routine analysis) and well defined reduction waves, it is essential to standardize pH and concentration of the base electrolyte. With very low concentrations of metals, vibration proved a source of difficulty. This was eliminated (*a*) by modification of the polarographic cell and (*b*) by the use of an efficient antivibration table for the electrode stand. Using these methods, good recoveries have been obtained for all four metals.

The second lecture, given by Dr. T. L. Parkinson of Beecham Foods Ltd., was entitled 'The Use of the Polarograph in the Food Industry with special reference to Oxygen Determination'. He began by outlining a few of the more important applications of polarography to food analysis, e.g. fructose in honey, wine and fruits; furfural and hydroxymethyl furfural in substances containing sugar degradation products; vitamins; oxidative rancidity in fats; nitrite in meat brines; anthocyanins in fruit; constituents of flavouring essences; trace metals and saccharin. He outlined some of the snags, and emphasized the need for adequate experiments to determine blanks and recoveries. He mentioned as an example the depression of the tin wave caused by iron in certain electrolytes, so that it is sometimes necessary to separate these metals by e.g. paper chromatography, before applying cathodic reduction. Dr. Parkinson drew attention to several problems that require investigation. Finally he outlined some work which had been done on the estimation of dissolved oxygen in carbonated beverages using the 'Wide Bore' technique and also a zinc micro-electrode.

The discussion of these papers took place immediately after lunch, and Mr. Condliffe was questioned on the possibility of interference by phosphate ions. Under normal conditions, these ions do not interfere in the methods outlined, but if calcium is also present, some metals, notably lead, may be partially lost by co-precipitation, and precautions have to be taken to guard against this. Some members present said that they had successfully employed a dithizone extraction procedure, prior to cathodic reduction in such cases.

The first paper after lunch, read jointly by Mr. J. R. Bishop and Mr. Hill of the Metal Box Co., Ltd., was entitled 'Oxygen Determination using the Mercury-plated Platinum Electrode'. They outlined the development of a vibrating micro-electrode consisting of a spiral of mercury plated platinum wire. This was devised by them in conjunction with Mrs. B. Lamb of Evershed & Vignoles Ltd., for the estimation of dissolved oxygen in canned foods, using the Tinsley pen recording polarograph (also used by Dr. Parkinson's laboratories for some of the work mentioned). During their investigations, these workers used a rotating micro-electrode, and also experiments involving rotation of the solution. It was eventually decided to use a cathode consisting of a spiral of mercury plated platinum wire sealed into glass. The anode consisted of a silver/silver chloride electrode of wire wound around the glass tube containing the cathode. The upper end of the anode was insulated to ensure the same area of electrode in contact with the solution in each experiment. This very compact electrode assembly is vibrated vertically at 50 c.p.s., and has the advantage that it may be inserted directly into the product, without removing the food or beverage from the can. These workers as well as Dr. Parkinson emphasized the difficulty of transferring samples without oxygen uptake from the atmosphere. Although the work is not yet completed, promising results have been obtained. A lively discussion followed.

Unfortunately, Mr. G. Russell of Ilford Ltd., was unable to be present to read his paper 'The Polarographic Determination of Metals in Solutions containing Gelatin'. This was ably read by a member of the College staff. The paper commenced with an apology for any false impression given by the title, since it is not usually desirable to have appreciable quantities of gelatin present when estimating metals by polarography. The paper consisted of a most interesting account of many of the minor constituents of commercial gelatin, with particular reference to those which are reducible at the dropping mercury electrode. Experiments on calcium (using E.D.T.A. and zinc) and iron (using o-phenanthroline) were described.

The colour film 'Oscillographic Polarography', describing the development of the polaroscope by Prof. J. Heyrovsky *et al.*, was shown before the tea interval. The polaroscope is now available commercially from Nash and Thompson Ltd.

The Czech film 'Polarography', which gives a thorough introduction to the technique of polarography concluded a very interesting and profitable day.—R. M. JOHNSON.

R.I.C. Public Lecture

The second Public Lecture arranged by the Royal Institute of Chemistry, London Section, is entitled 'The Story of Soap and the Growth of Modern Synthetic Detergents', and will be delivered by Dr. K. G. A. Pankhurst, D.Sc., F.R.I.C., at Hendon Technical College on Wednesday, March 29 at 7.30 p.m.

These Public Lectures are intended to inform non-scientists of the contributions which chemistry makes to daily life. They are of a popular nature, and will interest audiences composed of local residents, students and qualified scientists. They will not necessarily require a scientific background for their appreciation.

Space Heating Research Laboratory Opened

THE space heating research laboratory, recently opened at Colnbrook, Bucks., by Copperad Ltd., carries out work on a diverse range of subjects. Such widely different aspects of heating and ventilating as the durability of paint used on the company's products to such fundamental problems as the improvement of heat transfer coefficients under a variety of conditions are among the subjects investigated by the department.

The department is housed in an independent building with an area of 2,400 sq. ft. At the west end there are offices and a chemical laboratory occupying a total of 600 sq. ft. where simple qualitative analyses are carried out. The test section covers the other 1,800 sq. ft. of the building.

In the work being carried out on the fundamental principles of heat transfer and fluid flow, particular attention is being paid to improving the efficiency of the design of finned heat exchangers. Facilities exist for testing with water at temperatures up to 380°F. and with steam at pressures up to 200 p.s.i.

Testing New Plant and Materials

Another important aspect of the department's work is the testing of new and existing appliances. Each month a unit is picked at random from the company's production line and given thermal tests to ensure it is capable of producing its catalogue rating within the specified tolerance. The sample is also dismantled and each part is thoroughly inspected for imperfections.

Before the company uses a new material such as a paint, rubber, foam, plastic or adhesive, it is the task of the research and development department to evaluate these thoroughly.

Above: **The climate room which simulates temperature and humidity conditions occurring almost anywhere in the world.**

Right: **A general view of the new Copperad research laboratory.**

Another function of the department is to supply technical data for the company's catalogues. For instance in a recent case, to produce one set of performance figures a total of 942 separate tests was made. These included 450 emission tests with hot water, 125 with steam, and 367 air volume and added resistance tests.

Steam and Hot Water Supplies

A Bonecourt gas-fired steam boiler was chosen for supplying steam and hot water for testing equipment. It is rated at 500 lb./hr. at 200 p.s.i.g. and will heat water up to 380°F. (flow temperature). It also supplies the Copperad Raystrip and Wallstrip which heat the building.

Water used for heating appliances being tested is processed very thoroughly. Before being supplied to the boiler it is made to pass through a Permutit Deminrolit plant where dissolved solids are removed. It is then aerated to remove carbon dioxide, before being treated with sodium sulphite to remove oxygen. Caustic soda is then added to give a pH value of 9·5.

Steam used for testing equipment is also treated very thoroughly before use, as it is important to ensure that completely dry steam with a minimum of 2°F. superheat is supplied to any appliance. Treatment consists of passing the steam through two separators and a 4 kW. super-heater.

An important feature of the laboratory is that nearly all the test equipment used in the research department has been designed and constructed by Copperad personnel.

The Climatic Room

Of special interest is the climatic room which is used for testing fan coolers and fan convectors. The room, which is a 10 ft. cube, is heated or cooled by air entering at a low level and leaving at a high level or vice versa. Cold air to cool the room is supplied by a 5 h.p. semi-hermetic refrigerating set. This set will also supply chilled water to a fan cooler under test in the room. Temperatures can be controlled between 30 and 140°F. to within ± 1°F., and relative humidity to within ± 2 per cent between 20 and 95 per cent R.H. It will thus be seen that the climatic room is able to simulate conditions in which fan coolers and convectors might be required to operate in any part of the world.

The 'Quiet Room'

Another room is used mainly for design work and for routine checks on the sound level of every fan convector produced by the company and has therefore become known as the 'quiet room'. This consists in effect of two rooms, the inner one being flexibly supported by the walls of the outer. Walls of the inner room are lined with 2 in. thick Stillite held in place by perforated hardboard.

The outer room is also lined with 2 in. thick Stillite and is supported and raised from the concrete floor by mountings which absorb vibration. These features, along with double doors sealed with rubber, give a background sound level of about 38 decibels in the room.

Testing Unit Heaters

Another interesting device is a test platform for unit heaters. It is constructed of perforated angle iron and is used for testing horizontal discharge unit heaters. All tests on this equipment are carried out in accordance with the test codes of the Unit Heater Manufacturers' Association. For testing unit heaters against an added resistance an air volume test duct is used. Tests are made by measuring with a stroboscope the speed at which a fan rotates, by reading the resistance encountered on an inclined manometer, and air volumes with a mica vane anemometer or pitot head.

Testing Convector Heaters

For testing Copperad Wallstrip, Sill-Line and convector heaters with both water and steam a special convector test booth has been designed. This consists of a booth mounted several feet above the floor and open on one side. Dimensions are 10 ft. by 10 ft. by 8 ft. high.

Recorders are placed at each side of the booth as a check that the ambient temperature is steady in these areas. Temperature readings are taken from five thermometers or thermocouples suspended in front of the heater being tested and from similar instruments placed in the inflows and outflows of the pipes supplying the convector. The ambient temperature of the booth is also noted by a recorder placed outside and in front of the booth.

The booth conforms to the draft British Standards Specification for testing convection type space heaters recently circulated, to the U.S. convector code CS140, and to the U.S. Institute of Boiler and Radiator Manufacturers' Test Code for skirting board heating.

Other equipment used includes a rig for measuring water flow. It consists of a hot water tank with thermostatically controlled steam and electrical heating equipment, a circulating pump with control and by-pass valves, and measuring tanks calibrated in volume and fitted with changeover gear and quick emptying valves. A pump rig is installed for testing static head, the volume of flow, and cyclical operation in both hot and cold water. There is also a tensile test rig for testing fastening devices, spot welds, etc., to destruction.

High Frequency Titrimeter Type HFT 30 C

(*Concluded from page 171*)

technique, direct visual titrations can be performed in this case.

Fig. 4 shows two typical titration diagrams.

3. *Reaction kinetic measurement of thiosulphuric acid destruction.*—Thiosulphuric acid is markedly unstable and has a decided tendency towards destruction when in the form of a dilute solution. The kinetics of the destruction can be followed readily with High Frequency Titrimeter HFT 30 C in conjunction with beaker type HFZ 1. without danger of electrode poisoning occurring due to sulphur depositions.

Fig. 5 shows two destruction diagrams for thiosulphuric acid solutions of different concentrations. These measurements can be carried out very simply by use of the deflection method if the solutions under research with respect to their conductance do not fall within the 'critical range.' (Section a-b in Fig. 1).

A further simplification of the titration evaluation can be attained by connecting a recording instrument to the titrimeter.

The foregoing typical applications give an indication of the scope of 'electrodeless conductance measurements' and in particular the advantages to be gained by using high frequency techniques.

The precipitation tendency of supersaturated solutions such as barium carbonate can be determined very effectively by electrodeless conductance measurements. In this way the inoculation effect of electrodes immersed in the solution (platinum electrodes) is eliminated together with the danger of electrode incrustation when precipitation sets in.

WANTAGE RESEARCH LABORATORY

EARLY in 1956, work was begun to convert the buildings at Grove Airfield, Wantage, into a laboratory site for the isotope Division. The immediate programme was research Into the uses of large radiation sources which could be expected to become available in increasing quantities as fission products from spent reactor fuel elements. The site was then known as Wantage Radiation Laboratory.

The longer term plan was to move from Harwell other groups of the Division engaged on radioisotope research and to concentrate all such research at Wantage. Though one advantage of the site was its existing buildings, these offered only limited possibilities, and a building construction programme was prepared, which is now nearing completion.

The first comers to Wantage were members of Technological Irradiation Group who made use of such buildings as the Control Tower until their own building was ready. In its four years at Wantage, the Group has grown to almost a hundred strong and now operates a number of irradiation sources including cobalt-60 cells, a linear accelerator, a fuel element 'pond' at Harwell which makes use of the radiations available from spent reactor fuel, and the recently commissioned Package Irradiation Plant which is designed as a versatile pilot plant to give experience in commercial irradiations on a continuous basis.

The Technological Irradiation Group is concerned with radiation effects in three main fields: the initiation of chemical reactions, sterilization and plant genetics, and within these terms of reference the Group is sub-divided into five Sections:

Biology.—Concerned with the effects of radiation on plants, especially with mutation and the crossing of otherwise incompatible strains, and hence leading to improved breeding strains.

Chemistry.—Working mainly in the fields of polymerization, halogenation and oxidation, which give possibilities of improvements in plastics and various industrial chemical processes.

Entomology.—Investigating the effects of radiation in exterminating pests in stored products (e.g. weevils in grain and flour) and the control of other insects.

Food and Medical.—Studying the possibilities of sterilization by radiation as applied especially to the sterilization of surgical appliances and medical products, and long-term investigations into the preservation of food.

Physics and Engineering.—Responsible for the operation of the Group's irradiation facilities and for the design and development of industrial irradiation units.

More recent comers to Wantage have been the Isotope School, the Physics Group and latterly the Chemistry Group whose arrival completes the transfer of Isotope Research Division staff from Harwell. Still remaining at Harwell is the Reactors and Measurements Group, concerned with

Mr. J. N. Karkun of India and Dr. Bonoso of Chile working in the chemistry laboratory.

Dr. P. B. Cornwell examining flour mill moths which are used as test insects in the irradiation of flour.

experimental reactor irradiations and measurements of radioactivity. Its standards section is, however, located at Wantage, where it works closely with the Physics Group.

The Isotope School moved to Wantage last summer after eight years at Harwell and has continued to give basic training in the uses of radioisotopes in research, industry and medicine. Students come from all parts of the world. Besides the basic four week course, specialized courses are held on such subjects as medical applications, radiological protection and autoradiography, and there have also been courses for the non-technical directors of commercial organizations designed to show the potentialities of radioisotopes in industry. A two-day course for members of the Press was held in April, and courses are being planned for Trade Union representatives.

The Physics Group, which moved to Wantage last autumn, carries the main load of the Isotope Division Experimental and Advisory Service which endeavours to solve by adaptations of radioisotope techniques, practical problems posed by industry, hospitals and other bodies. The main activities of the Group are in the industrial uses of radioactive tracers for gas and liquid flow investigations and such problems as the efficiencies of mixing processes; the development of instruments for the detection and measurement of radiation; the application of radio-tracers to geological and allied problems such as measurement of coastal erosion, underground water movement and mineral prospecting, and, with Chemistry Group, investigations of metallurgical processes.

Chemistry Group, still in the process of removal from Harwell, is concerned with the chemical aspects of using radioisotopes in industry and medicine, including improvements in methods of preparing radioactive compounds. In analytical chemistry, the technique of radio-activation analysis enables minute constituent quantities to be detected and measured. In physical chemistry, metallurgical processes, such as electroplating and casting, have been studied to learn what happens at the various stages. The Group collaborates with hospitals in investigating the effects and distribution of radioisotopes in animals, and a small section conducts tracer research in bacteriology.

The Isotope Research Division is completed by the newly formed Industrial Liaison Group which demonstrates by visits to industrial areas the potentialities of radioisotope applications in commercial processes, and by a well stocked Library. Ministering to the needs of the Division are a small engineering unit, a store and a canteen.

A small team of D.S.I.R. scientists is attached to the Division for purposes of liaison.

STL Settle in at Harlow

STANDARD Telecommunication Laboratories Limited was formed in 1945 as a wholly owned subsidiary of Standard Telephones and Cables Limited (STC). An associate of the International Telephone and Telegraph Corporation (ITT), it is one of this organization's three advanced research and development laboratories, the others being at Paris (Laboratoire Central de Télécommunications) and Nutley, New Jersey (ITT Laboratories).

Starting in premises at Enfield, Middlesex, STL soon outgrew this location and leased several outstations to accommodate small specialized groups. One of these outstations was, and still is, at Frogmore Hall in Hertfordshire where there is a substantial stretch of reasonably level ground. This was to prove invaluable for propagation testing, and also for laying out long stretches of the novel circular, helical waveguide to test its radio wave transmission properties.

This led, in January, 1959, to the demonstration of the potentiality of this type of waveguide for carrying television programmes or equivalent information in various forms.

The installation, in 1956, of a £50,000 Van de Graaff particle accelerator at Enfield marked the beginning of radiochemical research into the effects of atomic irradiation on the properties of materials. The facilities of the Van de Graaff accelerator were extended by the radio chemical laboratory.

Even with its outstations, the Enfield establishment was soon found to be too small. Eventually, with the close co-operation of the Harlow Development Corporation a new laboratory, specially designed for its purpose, was built on the eastern boundary of Harlow New Town.

The Harlow Laboratories stand in 17 acres of ground and have a gross floor space in excess of 100,000 sq. ft. A four-storey block facing east houses administration, technical directorate, some laboratories and an information centre and large central library serving the many locations of STC and STL itself. Facing south are a pair of two-storey blocks of electronics laboratories, while to the north there are chemical and physical laboratories and central workshops.

Separated from the main building is the radiochemical laboratory associated with the 2 MeV. Van de Graaff accelerator, housed in special buildings.

The expansion of STL which has made the new buildings so necessary also indicates that these buildings will themselves be outgrown in the not too distant future. The site allows for expansion to the west, where additional electronic, physical and chemical blocks are planned.

LABORATORY EQUIPMENT & APPLIANCES

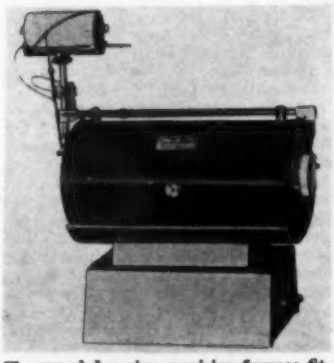
Laboratory Furnaces

A range of precision laboratory furnaces with exceptionally high stability of temperature (± 0·25°C.), an interchangeable drum control for thermal cycling, and facilities for heat loss compensation at the ends of the tube, has just been introduced.

In the standard range there are three models for maximum temperatures of 1,050°C. with tube sizes respectively of 35 mm. I.D. × 290 mm. length (for operation on 115 V. a.c.), 60 mm. × 450 mm. (220 V. a.c.) and 75 mm. × 700 mm. (220 V. a.c.); and two models for maximum temperatures of 1,250°C., with tube sizes of 35 mm. × 290 mm. (115 V. a.c.) and 60 mm. × 450 mm. (220 V. a.c.). Two special models for maximum temperatures of 1,500°C. are also available, with tube sizes of 16 mm. × 250 mm. (115 V. a.c.) and 35 mm. × 400 mm. (220 V. a.c.).

The furnaces are of extremely versatile design. The standard models may be controlled either by a thermostatic regulator or a chronograph drum control for thermal cycling, these temperature-control arrangements being easily interchangeable by the user.

The thermostatic regulator is an ingenious and reliable mechanism enabling the furnace temperature to be controlled within ± 0.25°C. at any desired level below the maximum. The device consists of a graduated scale and a pointer operated by a dilatable wire running through the furnace body. The scale is fitted with a stop which may be set to any desired temperature. When the pointer reaches the stop, the current is automatically cut off from the windings via the 8-volt relay. The temperature is set initially with the aid of a thermocouple.



Chevenard-Joumier precision furnace fitted with chronographic drum control.

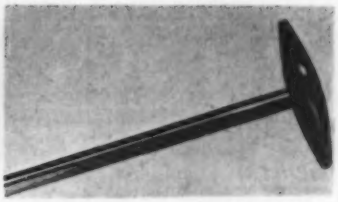
The thermostatic regulator is interchangeable on the standard models with a chronograph drum control for thermal cycling. The drum is clockwork-operated as standard but an electrically-driven version is available as an alternative. The drum carries a temperature chart on which the desired thermal cycling programme is marked out by a strip of thick cardboard. In operation, the drum revolves at a set speed (the gearing arrangements provide two speeds), and, as the furnace heats up, a specially-designed contact on an arm connected to the dilatable wire moves across the drum. When it meets the cardboard, the relay operates and the current is cut off. In this way the contact follows closely the edge of the cardboard strip, alternately making and breaking the circuit to the windings, and thus holding the temperature to the planned programme.

The three separate windings are mounted side by side along the tube and may be controlled individually by shunt rheostats, thus enabling the temperature to be varied along the tube for special work or to compensate for the extra heat loss at the tube ends inherent in this type of furnace.

All models may be mounted vertically or horizontally. For vertical mounting the furnace casings are fitted on each side with a drilled or tapped boss enabling them to be secured to a suitable support. For horizontal mounting three different bases are available—a metal tripod with screw adjustment on each foot, a box pedestal housing the relay and its associated transformer and incorporating a mains switch, or a potentiometric pedestal incorporating the relay and transformer, mains switch and three shunt rheostats for controlling the three individual windings. All models may be fitted with a water jacket, e.g. for use in a glove box.

The two special 1,500°C. models are developed from the standard types. They are available only with a chronograph drum control, which is not interchangeable with a thermostatic regulator, and incorporate special windings of platinum-rhodium wire. Like the standard models they may be mounted either vertically, or horizontally on any of the three available bases.

(Available from: Shandon Scientific Co., Ltd., 6 Cromwell Place, London, S.W.7).



Porous stainless steel filter.

Laboratory Filters

A newly redesigned line of porous stainless immersion tubes, beaker filters and gas dispersion tubes is now available. These units feature type 304 stainless steel tubes heliarc welded to the centre of type 316 porous stainless steel filter elements. Elements are dished to a spherical radius.

The filters are available in five porosity grades, with average pore openings of 65, 35, 20, 10 and 5 microns. They can be heated to 400°C. without change of weight due to oxidation. Combining light weight and high flow rates with resistance to thermal or mechanical breakage, they are suitable for a variety of laboratory uses.

The relative chemical inertness of these units makes them useful with all alkalis, hot or cold, and with most acids. They can be cleaned by back-washing or by chemical treatment.

(Manufacturers: Micro Metallic Division, Pall Corporation, 30 Sea Cliff Avenue, Glen Cove, New York).

Packaged Air Conditioners for Specialized Uses

A new range of packaged air conditioning units specifically designed for laboratories has recently been introduced.

The necessity for air conditioning in research and other industrial laboratories has grown with the increasing requirements for accuracy and uniformity in many production and testing operations. This, of course, is only possible when atmospheric conditions are strictly controlled. These Carlyle laboratory conditioners have cooling capacities from 29,000 to 54,000 B.Th.U./hour, as well as an electric heater battery and humidifier. Temperatures and humidities over a wide range of conditions can be obtained within close tolerances for laboratory work.

The units are manufactured in two sizes (Models 50R4 and 50R6). Each consists of an assembly of well-balanced refrigeration, air handling, heating, humidifying and control-systems, packaged in a modern styled cabinet, ready for water and electrical service connections.

(Manufacturers: Carlyle Air Conditioning and Refrigeration Ltd., 1 King Street, St. James's, London, S.W.1.)

NEWS

General

The Hirst Research Centre

A new structure for the Wembley Research Laboratories of The General Electric Co. Ltd., has been announced by the company's Director for Research and Technical Development, Mr. O. W. Humphreys. Autonomous research units operating side by side, each sharing the same scientific and administrative services, will be set up. This will enable those of the seven groups and the subsidiaries of the company that wish to do so to have research units under their own control, thus securing a closer integration of applied research and development than in the past. To mark this fundamental change in policy, it has been decided to re-name the Laboratories. They will be known as 'The Hirst Research Centre' as a tribute to the founder of the G.E.C., the late Lord Hirst.

Under the new scheme, two main research units are planned as a first step. One or two group research laboratories will follow almost immediately and others later. The main units are the Central Research Laboratories and the Telecommunications and Engineering Research Laboratories.

Mr. V. J. Francis will be the Deputy Director in charge of the Central Research Laboratories. They will be responsible for the majority of the more fundamental research programmes whether on behalf of the company as a whole, the groups or subsidiaries. They will provide specialized scientific and technical services and advice to the whole of the Centre, and will ensure effective scientific liaison between all research units.

The primary responsibility of the Telecommunications and Engineering Research Laboratories will be work on behalf of the Telecommunications and Engineering Groups of the company and fundamental researches in related fields. Mr. R. J. Clayton, the Deputy Director in charge of these laboratories, will also carry the senior responsibility for administration of the Centre.

The Central Research Laboratories and the Telecommunications and Engineering Laboratories will continue to act for groups which do not, for the time being, set up their own research units. The changeover will be gradual. When complete, the system will be so flexible that any one research unit in the Centre will be able to take on work for another unit by mutual agreement.

This evolution is a logical step following the formation at the beginning of the year of five new operating groups of G.C.E. The five—Domestic Equipment, Installation Equipment, Lighting and Heating, Osram, and Radio and Television—joined the Telecommunications and Electronics Group and Engineering Group to make up seven complete units for production and sales.

Now, a closer association will be possible between the research units and the seven groups. The tighter coupling between applied research and development resulting from unified management will enable new products to be marketed more swiftly.

The Elgastat in Action

The following awards have been made in the photographic competition organized by Elga Products Ltd.:

1st Prize: £30. Challenge Cup and Merit Award of £2.10s.0d. K. Worthy, Esq., Senior Biology Master, Rhyl Grammar School, Grange Road, Rhyl.

2nd Prize: £25. and Two Merit Awards £10. B. J. Francis, Esq., F.I.M.L.T. Senior Laboratory Technician, Pathology Department, St. David's Hospital, Cardiff.

3rd Prize: £20. Chief Laboratory Technician, Public Health Laboratory, Woodbridge Road, East, Ipswich.

4th Prize: £15. and One Merit Award of £2.10s.0d. R. H. Calvert, Esq., 8 King Street, Stubbins, Mytholmroyd.

5th Prize: £10. F. Vine, Esq., 12 Kent Avenue, East Cowes, Isle of Wight.

Two Merit Awards: £10. R. Marlow, Esq., Technician, Anatomy Department, Marischal College, Aberdeen.

The Judges Panel consisted of three amateur and three professional photographers:

Mr. A. S. A. Wooster, A.R.P.S.,
Mr. P. M. Coulon, A.I.B.P.,
Mr. J. P. Mauder,
Mr. J. Phipps,
Mrs. L. Moller,
Mr. E. F. G. Saxby (absent due to force majeure).

The prize winning photograph submitted by Mr. K. Worthy in the Elga Products Competition.

British Laboratory Ware Association

The following manufacturers of laboratory apparatus have recently been elected Associate Members of the Association:

Beatson, Clark & Co., Ltd., Rotherham.
Davey & Moore Ltd., Bromsdown, Middx.
Electro-Thermal Engineering Ltd., London, E.7.
Helix Universal Ltd., Lye, Stourbridge.
T. & W. Ide Ltd., Glass House, Glass House Fields, Ratcliffe, E.1.
Isopad Ltd., Boreham Wood, Herts.
Nickel-Electro Ltd., Smethwick.
John Poulten Ltd., Barking, Essex.
R. & L. Enterprises Ltd., Stanningley, Pudsey, Yorks.

Manufacturers News

New Instrumentation Division for Quickfit

An advanced technical-development unit designed to keep abreast of the expanding market for automation and instrumentation in laboratory apparatus is to be formed at Abingdon by Quickfit & Quartz Ltd.

Manager of the new division will be Mr. R. N. Jukes, who has previously been responsible for design of laboratory apparatus at the Stone (Staffordshire) factory.

Quickfit hope to have the unit operational in premises at Ock Mill, Abingdon, Berks., by next spring.

New Board Appointments at Ultrasonics Ltd.

Ultrasonics Ltd. is now organized in two separate Divisions:

1. The Mechanical Division, which is concerned with the manufacture of the patented Rapisonic and Minisonic Homogenizers.
2. The Electronics Division, which deals with the construction of the Rapiclean ultrasonic cleaning plants.

Mr. John S. Smith joins the Board with special responsibilities in the Mechanical Division. He has held previous appointments with Keighley Lifts Ltd. and A. V. Roe Ltd., where he was Assistant to the Chief Designer. Mr. Smith has taken a prominent part in the application and development of the Rapisonic principle having joined the company in 1954.

Mr. B. B. Fordham, A.M.I.Mech.E., is the other newcomer to the Board. He has been the company's Chief Engineer since May, 1958. Mr. Fordham held previous appointments with Herbert Morris Ltd., and with Mono Pumps Ltd. He was the latter company's Yorkshire Manager.

Ultrasonics Ltd. is a subsidiary of the Croda Organisation Ltd., whose Chairman and Managing Director is Mr. F. A. S. Wood.

Electronic Materials Corporation

Dr. R. C. Vickery and H. M. Muir, co-discoverers of the recently announced thermoelectric 'breakthrough' material, gadolinium selenide, have formed a new company to prepare, and conduct research and development studies in advanced materials necessary at the forefront of space age technology. The thermoelectric properties of gadolinium selenide were announced at the American Rocket Society Space Power Symposium in Santa Monica in September 1960, and have created great interest in military and industrial circles. Thermoelectric materials will, however, be only part of the interests of this new Corporation which will enter electronic, magnetic, energy conversion, high-temperature and rare element materials fields.

Located in Santa Monica in temporary premises at 2200 Colorado Avenue, Electronic Materials Corporation is fully equipped for and will conduct research on materials of high interest to governmental and industrial agencies. Their facilities include an extensive and well-instrumented laboratory allowing investigation and analysis into every aspect of the solid state.

Physical Society 1961 Craftsmanship Competition

In the Blown Fused Silica Ware Section of the Physical Society Craftsmanship competition, entries submitted by employees of the Thermal Syndicate Ltd., gained 1st, 2nd and 3rd prizes and an honourable mention.

The entries were on show at the Institute of Physics and Physical Society Exhibition.

School Laboratory Equipment on Show in Belfast

Quickfit & Quartz exhibited a complete set of laboratory assemblages specially designed for use in schools and colleges at an exhibition organized by the Science Masters' Association (Northern Ireland branch) at the Grosvenor High School, Belfast, on February 17-18.

Exhibits included sets of apparatus for the educational field, designed to save time by speeding up assembly. Components are completely interchangeable, and are made of heat and chemical resistant borosilicate glass.

Camlab's New Home

Camlab (Glass) Ltd. announce that they have now completed their move to new premises at Milton Road, Cambridge (*Tel.*: Cambridge 52261).

In their new situation Camlab have three times their previous area, with an option on further accommodation when required; this has enabled them to increase their glass-working capacity to cope with the growing demand.

The extra warehouse space now available has given an opportunity for the build up of stocks of lamp-worked and graduated glassware, Grant baths, and other specialities, in addition to standard apparatus for which an off-the-shelf service may now be expected.

Publications

Opportunities for School Leavers

The 1961 edition of The Directory of Opportunities for School Leavers has now been published (Cornmarket Press Ltd. 8s. 6d. (paper-back 5s.)).

The number of chemical firms giving their recruitment requirements in this latest edition is nearly double the number listed in 1960. The total number of entries in the Directory has increased by 32 per cent from 165 to 218 and of these 19 are chemical companies. Other increases are under the headings of electronics, mechanical engineering, electrical engineering and chemical and civil engineering.

The editorial section is both valuable to the school leaver and easy to read. 'Going to University' provides for the mystified would-be undergraduate, and for his parents, a concise guide through the intricacies of university entrance requirements. The professions are covered in an authoritative article; technical training and apprenticeship are both dealt with and there is an article on 'Opportunities for Girls in Industry.'

The reference section sets out in detail information about commercial and industrial organizations and government departments. The classified index summarizes in tabular form further information about the size of the organizations and the areas in which employment is offered. A new index has been added which gives details of training schemes offered by each company.

Animals for Cancer Research

The report of a Symposium on 'The Provision of Animals for Cancer Research' held at the Royal Society of Medicine on May 23, 1960 has now been published by the Laboratory Animals Centre. (Collected Papers, Vol. 9, Laboratory Animals Centre, M.R.C. Laboratories, Woodmansterne Road, Carshalton, Surrey, Price 12s. 6d.).

The papers included in this volume are: Introductory Paper: The Provision of Animals for Cancer Research, by Prof. J. S. Mitchell; Fundamental Programmes in Causation, Prevention and Therapy, by Prof. Alex Haddow; Spontaneous Tumours in Mice, by P. R. Peacock; Present Trends and Future Applications in the Use of Animals for Research in Carcinogenesis and Tumour Chemotherapy, by D. L. Woodhouse; Some Problems of Cancer Chemotherapy from the Chemist's Point of View, by Prof. F. Bergel; Laboratory Animals and Metastisizing Tumours, by P. Loustalot; The Epidemiology of Polyoma Virus in a Mouse Colony, by M. H. Salaman and K. E. K. Rowson; Problems in Laboratory and Animal Procurement for the Cancer Chemotherapy National Service Centre, by George E. Jay; Comments on the Inefficiencies Inherent in Traditional Methods of Small Scale Mouse Husbandry for Cancer Research, by J. G. Bennette; Animal Supply and Demand in Practice and Anticipation, by June East; The Supply of Avian Material: Factors to be Considered in Selecting Supplies, by J. G. Carr; Pitfalls in the Production of Cancer Cells for Experimental Purposes, by F. Kingsley Sanders; Financial and Administrative Considerations, by J. D. Whittaker; Summary of the Proceedings.

CATALOGUES, BROCHURES & LEAFLETS

Received from Manufacturers

B.D.H. Leaflets.—New entries in the catalogue of British Drug Houses Ltd., of Poole, Dorset, are listed in the January 1961 issue of their monthly leaflet. These are as follows: *Organic and Inorganic Chemicals.*—2-amino-2-methyl-propane-1:3-diol; 1:6-diaminohexane; tetramethylammonium chloride. *Biochemicals.*—Uridine diphosphoglucose disodium salt. *Ion Exchange Materials.*—Amberlite ion exchange papers; Whatman cellulosic ion exchangers.

Mobile Aids for Cleaning.—A leaflet describing their Clean-Aid equipment has been issued by Powell & Co., Burry Port, Carmarthenshire. Included in the leaflet are details of a mopping tank trolley, sweep-up barrows, a bucket trolley, bin carriers, trucks, a bin bogie, a roller wringer bucket and a carry-all cleaner's trolley.

Broadsheet of Laboratory Equipment.—W. Markes & Co., Ltd., of Wolverhampton Road, Wedges Mills, Cannock, Staffs., have issued a useful broadsheet giving an outline of the taps, cocks and valves for water, gas, steam, compressed air and vacuum services in the modern teaching, research and industrial laboratory.

Laboratory Supplies.—The new 1961 catalogue issued by A. D. Wood, 4-5 Skinner Street, London, E.C.1, contains details of their existing range and some important additions. For example, micro scaffolding based on ¼ in. rods and largely manufactured from stainless steel, a new type of burette holder and a blast burner. The Speedivac Speciality Service continues to operate satisfactorily and all stocks have been extended to meet the demand. This new catalogue also brings up to date the stopcock section and the company are also able to supply electrothermal heating equipment.

MEETINGS FOR THE MONTH

Mid-March to Mid-April

We give below a selection of meetings of interest to laboratory workers. Details are as full as possible at the time of going to press, but readers requiring further information or confirmation of arrangements should contact the organizers.

March 8

The Society for Analytical Chemistry (Midlands Section). At the Technical College, Luton. 6.30 p.m. 'Some Newer Reagents in Analytical Chemistry,' by Prof. R. Belcher, D.Sc., F.R.I.C.

March 9

The Chemical Society (Bristol). In the Department of Chemistry, Bristol University. 6.30 p.m. Society of Chemical Industry Annual General Meeting and film 'Water Treatment.' Joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry.

March 10

The Institution of Chemical Engineers. At the Midland Hotel, Manchester. 3.30 p.m. Annual General Meeting followed by Annual Dinner and Dance.

The Society for Analytical Chemistry (Western Section). At Swansea. Joint meeting with the South Wales Section of the R.I.C. on 'Vapour Phase Chromatography,' by A. Verdin.

Royal Institution of Great Britain. At 21 Albemarle Street, London, W.1. 9 p.m. 'Energy,' by Ronald King, B.Sc., Ph.D., F.I.M., M.R.I.

The Chemical Society (Birmingham). In the Chemistry Department, Birmingham University. 4.30 p.m. 'Very Fast Chemical Reactions,' by Prof. G. Porter, M.A., Ph.D.

The Chemical Society (Cambridge). In the Chemical Laboratory, Lensfield Road, Cambridge. 8.30 p.m. 'Some Aspects of the Radiation Chemistry of Aqueous Systems,' by Prof. J. Weiss, Ph.D. Joint meeting with the University Chemical Society.

March 13

The Chemical Society (Cardiff). In the Chemistry Department, University College, Cathays Park, Cardiff. 5.30 p.m. 'Some Aspects of the Chemistry of the Sesquiterpenes,' by Prof. W. Cocker Ph.D., Sc.D., F.R.I.C.

The Chemical Society (Durham). In the Science Laboratories, Durham University. 5 p.m. 'Aromatic Fluorocarbons,' by Prof. M. Stacey, D.Sc., F.R.I.C., F.R.S.

March 14

The Society of Instrument Technology (Manchester Section). At the Nag's Head, Jacksons Row, Manchester. 6.45 p.m. Brains Trust on Maintenance.

The Society for Analytical Chemistry (Midlands Section). At Regent House, Birmingham. 6.30 p.m. Annual General Meeting.

March 15

The Institute of Science Technology (London Branch). At the Chemistry Department, Imperial College of Science, S.W.7. 6.30 p.m. 'Radiation Hazards,' by Dr. S. H. Revell.

March 16

The Society of Instrument Technology (Grangemouth Section). At the Leapark Hotel, Grangemouth. 7 p.m. Annual General Meeting followed by Film Show on Transistors.

The Society of Instrument Technology (Newcastle Section). In the Conference Room, Roadway House, Oxford Street, Newcastle upon Tyne, 1. 7 p.m. 'The Rotameter sheds its Limitations,' by H. Williamson, A.M.I.E.E., Grad.I.Mech.E.

The Chemical Society (Aberystwyth). In the Edward Davies Chemical Laboratories, University College, Aberystwyth. 5 p.m. 'Cyclobutadeine—A Success Story,' by Dr. J. W. McOmie.

The Chemical Society (Sheffield). In the Chemistry Department, Sheffield University. 4.30 p.m. 'Some Recent Developments in Agricultural Chemistry,' by Prof. R. L. Wain, Ph.D., F.R.I.C., F.R.S.

March 17

Royal Institution of Great Britain. At 21 Albemarle Street, London, W.1. 9 p.m. 'Magnetism and Chemical Architecture,' by R. S. Nyholm, D.Sc., F.R.I.C., F.R.S.

March 21

The Chemical Society (Swansea). In the Department of Chemistry, University College, Swansea. 4.30 p.m. Simonsen Lecture, 'Biosynthetic Routes to Phenolic Compounds,' by Prof. A. J. Birch, F.A.A., D.Phil., F.R.S.

March 22

The Society of Instrument Technology (Tees-side Section). At the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough. 7.30 p.m. Annual General Meeting followed by 'Some Impressions of Instrumentation in the U.S.S.R.,' by E. N. Martin.

The Institution of Mechanical Engineers. At 1 Birdcage Walk, London, S.W.1. Ordinary Meeting: James Clayton Lecture—'The Application of Mechanical and Biological Knowledge in Engineering,' by Sir Frederic Bartlett.

March 23

The Society of Instrument Technology. (Chester Section). In the Lecture Theatre, Administration Building, The Associated Ethyl Company Ltd., Oil Sites Road, Ellesmere Port, Wirral. 7 p.m. 'Electromagnetic Flowmeters,' by Leo M. Bennett.

The Society for Analytical Chemistry (Midlands Section). At the Technical College, Nottingham. 7 p.m. 'Measurement of pH and Electrode Potential for Analytical Purposes,' by Dr. G. Mattock.

March 24

The Society of Instrument Technology (Scottish Section). At the Building Centre, Sauchiehall Street, Glasgow. Annual General Meeting followed by a report from Prof. G. D. S. MacLellan on the Moscow Congress.

The Society for Analytical Chemistry (Scottish Section). In Glasgow. Meeting on 'Non-aqueous Titrimetry.' Speakers: G. R. Jamieson, B.Sc., A.R.I.C., and E. S. Lane, B.Sc., Ph.D., F.R.I.C.

March 25

The Society for Analytical Chemistry (North of England Section). At the City Laboratories, Mount Pleasant, Liverpool. 2.15 p.m. Joint meeting with the Physical Methods Group of the Society on 'The Analysis of Intact Samples.'

March 29

The Society of Instrument Technology (South Wales Section). In the Welsh College of Advanced Technology, Cardiff. 6.45 p.m. Annual General Meeting followed by 'Feed Back,' by R. S. Medlock, B.Sc., A.R.I.C., A.M.I.E.E.

The Society for Analytical Chemistry. In the Chelsea College of Science and Technology, Manresa Road, London, S.W.3. Demonstration meeting of laboratory built equipment.

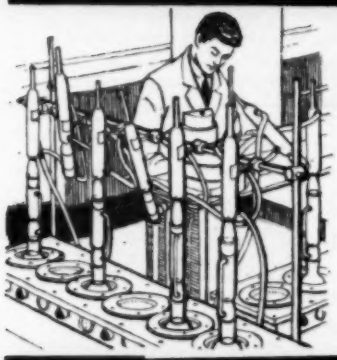
April 3

The Society of Instrument Technology. (South Yorkshire Section). At the University, St. George's Square, Sheffield, 1. 7 p.m. Annual General Meeting followed by the chairman's address. 'Feed Back in Management Control,' by M. Thomas, M.A.

The Expert Witness

The Association of Consulting Scientists and the Forensic Science Society held a colloquium on 'The Expert Witness' at the School of Pharmacy, Brunswick Square, W.C.1, on Friday, March 3, when the speakers were C. Keith Simpson, M.D., M.R.C.P., (Reader in Forensic Medicine, University of London), Leonard Caplan, Q.C. (Barrister-at-Law), and Henry Elam, M.A. (Deputy Chairman, London Sessions).

EXTRACTION AND DISTILLATION UNITS



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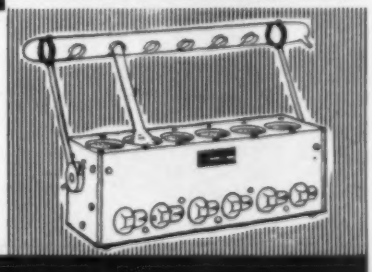

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In chromatographic work these papers show several advantages over an ion exchange column, among them smaller samples, shorter time, and no fraction collecting, and often the fractions may be stained direct.

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'Amberlite' WA-2	Carboxylic acid	H^+	Copper, cobalt, nickel; vitamins
'Amberlite' SB-2	Quaternary ammonium	Cl^-	Iodide, iodate, periodate; carbohydrates
'Amberlite' WB-2	Primary and Secondary amine	OH^- (free base)	Fatty acids; haemoglobin

Used as filter media the papers should remove traces of ionisable impurities from solution, and clarify the solution at the same time. Further information on their properties and uses is contained in the B.D.H. leaflet "'Amberlite' Ion Exchange Papers" which is available free on request.

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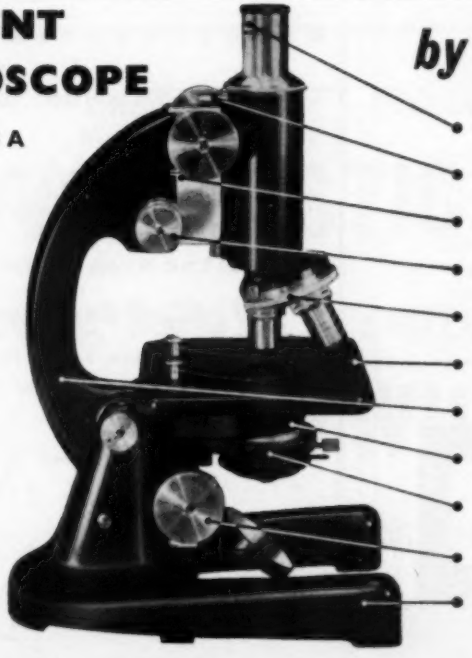

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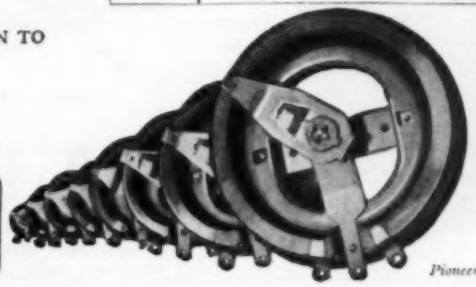

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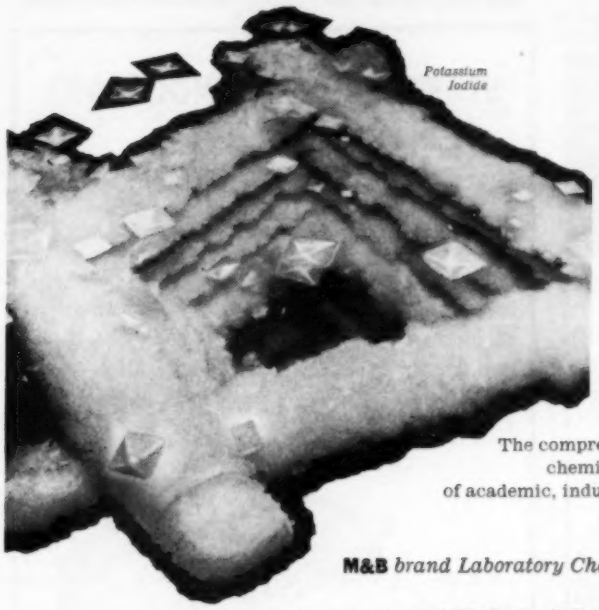
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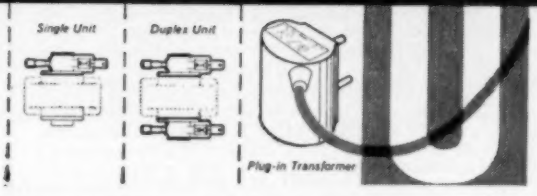

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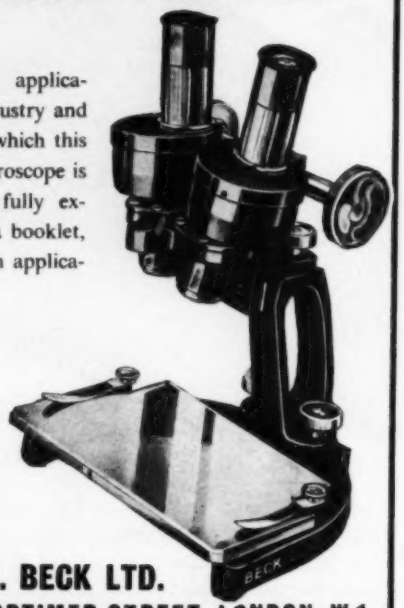

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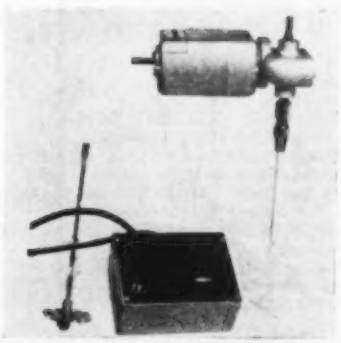

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is a highly selective medium for isolation of *Salmonella typhosa*. The unusual selective properties of this medium permit the use of large inocula of faeces and other suspected material without overgrowth of extraneous intestinal bacteria.

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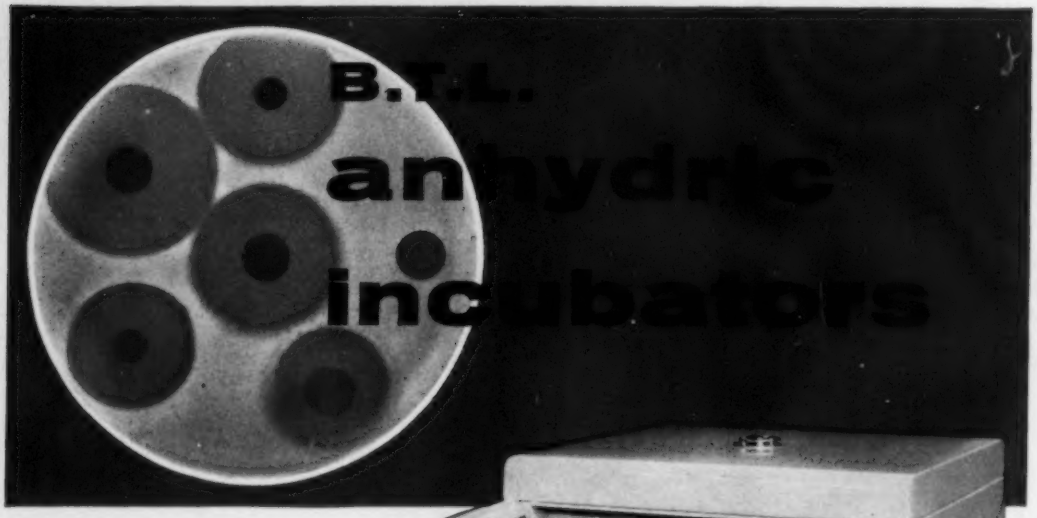

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